Gender differences in adult numeracy: a comparative study

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Declaration

I, Rose Cook, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This thesis presents a comparative study of gender differences in adult numeracy in 20 OECD countries. It explores the ways in which the widespread male advantage in adult numeracy is associated with gender relations. Gender relations are measured in terms of gender differences in power and status, the gender division of paid and unpaid labour, and gender culture. The thesis uses quantitative secondary analysis of data from the OECD's 2012 Programme for International Assessment of Adult Competencies (PIAAC), which provides direct measures of adults' numeracy skills. The analysis proceeds from an original theoretical framework which combines insights from life course research on the determinants of skills in adulthood, as well as integrating feminist theory of multidimensional gender relations. At the individual level, the results demonstrate that female advances in education do not necessarily equalise adult numeracy. Women's participation in the labour market is also not enough to guarantee equal levels of adult numeracy: women must also be able to access occupations that use numeracy skills. Cross-nationally, there is no obvious empirical relationship between gender inequality, conventionally conceived, and the gender difference in adult numeracy. Instead, paradoxically, gender differences in adult numeracy are larger in societies that combine egalitarianism with gender segregation in the labour market, and smaller in countries with relatively inequitable gender relations. Overall, there is little evidence that gender differences in adult numeracy are associated with conventional indicators of gender inequality in this sample of countries. The thesis thereby questions the findings of previous research and suggests that instead of being framed as an outcome of female disempowerment, gender differences in adult numeracy should be understood in relation to the multidimensionality of gender relations in post-industrial societies.

Impact statement

The knowledge generated in this thesis has the potential for impact on knowledge, policy, and practice. Firstly, the empirical evidence presented in the thesis contributes to two growing, international literatures: one on inequalities in adult skills; the second on gender and cognitive skills in cross-national perspective. The theoretical framework conceived and evaluated in this thesis brings together insights from life course research on the determinants of skills in adult life, as well as feminist theory of gender relations. This approach provides a useful framing for understanding gender differences in educational and employment outcomes which can be adopted in future research. The insights in this thesis will therefore be valuable to scholars across a range of disciplines including comparative sociology, comparative education, psychology, and gender studies.

Beyond academia, trends and patterns in gender and education are of great interest to policy makers, the media, and the general public. Numeracy is a key skill in contemporary societies due to its links with social and economic functioning, civic participation, economic prosperity, and innovation. Evidence presented in this thesis therefore has the potential to influence public debate and policy formation in the arenas of education, skills, and employment. The potential impact is enhanced by the fact that the findings challenge existing studies in this area, many of which have received considerable media coverage and policy attention. These impacts can be brought about via publication of the findings in diverse settings including scholarly journals, blog posts, briefings, and media articles.

One of the key findings from this thesis is that empowering women in terms of education and in economic life does not necessarily reduce gender differences in adult numeracy. This suggests that to solve gender differences in adult numeracy, policy efforts should be reframed to focus on subtler or taken-for-granted forms of gender inequality, such as segregation in employment. Policy responses could include gender mainstreaming, as well as more direct strategies such as positive discrimination and segregation audits. The findings also echo existing studies which call for improvements in working conditions and improved valuation of female-dominated occupations, adding a new emphasis on skills use. Post-Soviet countries have low levels of gender segregation in this respect, as well as relatively small gender differences in adult numeracy. Although post-Soviet countries have a unique history in terms of women's employment, and are highly patriarchal in some respects, policy insight could be drawn from the structure of employment in these countries.

To enhance the potential impacts of the research agenda advanced in this thesis I also recommend that further research should be conducted into three key areas: (1) the links between configurations of gender relations and gendered outcomes in the broader STEM sphere, (2) the mechanisms linking segregation in employment and gender differences in adult numeracy, and (3) the consequences of gender differences in adult numeracy career development, lifetime earnings, health, wellbeing, and civic participation.

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1. Introduction and theoretical framework

1.1 Introduction

In 2013, the Organisation for Economic Co-operation and Development (OECD) reported the results of their large-scale international study of adult skills, the Programme for International Assessment of Adult Competencies (PIAAC). The participants in this study were nationally representative samples of adults between the ages of 16 and 65 in 24 OECD countries[1]. Between 2011 and 2012, these adults participated in a household survey in which they completed assessments of their literacy, numeracy, and problem-solving skills, as well as a background questionnaire on their socio-economic background, education, and labour market experiences. The resulting report identified that in most countries surveyed, men performed better on the numeracy assessment than women (OECD 2013a).

The goal of this thesis is to identify potential reasons behind gender differences in adult numeracy. This is achieved using secondary analysis of the PIAAC data and supplementary data from a range of sources. The thesis aims to identify common factors that are associated with the male numeracy advantage in all countries where it exists, as well as examining how and why the influence of gender on adult numeracy varies cross-nationally. The three main empirical chapters address parts of the unified theoretical framework detailed in this chapter. This theoretical framework synthesises areas of research that have rarely been brought together before, combining insights from life course research on the determinants of skills in adult life and feminist theory of gender relations. I label this framework an *integrative micro-macro* framework. It is integrative because it considers characteristics

[1] Approximately 5000 adults were sampled in each country. This thesis uses data from the countries included in the first data collection in 2011–2012, which included Australia, Austria, Belgium (Flanders), Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Russian Federation, the Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland), and the United States. Later data collections included Chile, Greece, Indonesia, Israel, Lithuania, New Zealand, Singapore, Slovenia, Turkey (in 2012–2016) and Ecuador, Hungary, Kazakhstan, Mexico and Peru (in 2016–2019).

and experiences of individual adults (the micro-level), as well as the context of the societies they live in (the macro-level). The theoretical framework motivates the following broad research questions:

- How can we understand gender differences in adult numeracy?
- How are gender differences in adult numeracy related to gender-differentiated educational experiences?
- How are gender differences in adult numeracy related to gender segregation in the labour market?
- How are gender differences in adult numeracy related to country-level gender relations?

These research questions are specified in greater detail in section 1.3.

The purpose of this introduction is to explain the motivation for the thesis, to outline its structure, and to describe the theoretical framework that informs the research questions and subsequent empirical analysis. The next section is dedicated to defining 'adult numeracy' and explaining the motivation for studying gender differences in adult numeracy.

1.1.1 What is adult numeracy?

The term 'adult numeracy' denotes a set of skills which, though related, are distinct from early numerical skills, adolescent mathematical achievement, or 'general cognitive ability' (Coben 2003; Condelli 2006). While authors disagree about the type and level of mathematical content involved, the broad consensus is that numeracy is mathematical activity situated in applied cultural and social context (Coben 2003; Condelli 2006; Geiger et al. 2015). Numeracy goes beyond the mechanics of addition, subtraction, multiplication, and division. It may include some knowledge and application of statistics and probability. Most importantly, numeracy involves the ability to apply mathematical knowledge to real-life situations and to communicate about quantitative issues. It is therefore a multi-layered skill, incorporating not only mathematical knowledge but also communicative, cultural, social, emotional, and personal components (Condelli 2006). Reflecting this scholarly consensus, the OECD defines numeracy for the purpose of PIAAC as: ‘the ability to access, use, interpret and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life’ (OECD 2013: 20). The PIAAC numeracy assessment was accordingly designed to present a range of real-life situations intended to elicit such numerate behaviour (PIAAC Numeracy Expert Group 2009).

Real-life situations that involve numeracy include personal decision-making, practical activities, and interpreting written, numerical, and graphical information of various kinds (PIAAC Numeracy Expert Group 2009). For example, personal decision-making could include making healthcare decisions, which can involve assessing risk and calculating medication dosages; understanding school performance league tables; financial planning; and purchasing insurance (PIAAC Numeracy Expert Group 2009: 8). At home or in the workplace, one may need to undertake practical activities involving designing, making and measuring physical or virtual objects. Understanding how to interpret graphical and numerical information can facilitate the effective understanding of media, as well as effective functioning in the workplace (Steen 2001; Gal 2002).

To complete numeracy test items located in these contexts, one must apply mathematical skills such as calculation, the application of rules or probabilistic thinking, but also, importantly, one must understand the broader context, relevance, and meaning of the problems presented. Test items may not be presented in mathematical terms. Individuals therefore need to identify that a test item involves numeracy, choose from a range of possible methods to solve it, then communicate the solution in a way that is broadly understandable (Coben 2003). To do this, adults may draw upon the mathematical knowledge they have obtained through formal schooling. However, mathematics adults have learned through their education is not always directly transferable to numeracy-related situations in adult life. Instead, multiple varieties of numeracy are developed and used by adults in the context of their everyday lives (Nunes et al. 1993; Lave & Wenger 1991). Thus, while adult numeracy builds upon the mathematical skills developed earlier in life, it is a distinct and dynamic set of abilities.

Adult numeracy is often invisible, confused with 'common sense' or general intelligence (Coben 2003). Yet numeracy scores resulting from controlled assessments equate to highly useful indicators of individuals' productive capacity and are strongly related to opportunities in life. It is argued that good quality measures of adult numeracy, along with literacy, contain more information about individuals' economic productivity (i.e. earning power) than educational data, such as years of schooling or qualifications (Green & Riddell 2001; Hanushek & Woessmann 2008). While good numeracy skills are highly advantageous, 'poor numeracy skills make it difficult to function effectively in all areas of modern life' (Parsons & Bynner 2005: 6–7).

1.1.2 Gender differences in numeracy and related skills

Gender differences in cognitive skills have been studied intensively in both the social and biological sciences, particularly since the publication of Maccoby and Jacklin's influential book, *The Psychology of Sex Differences* (Maccoby & Jacklin 1974). This book ignited the debate on gender differences in intellectual capacities, including numeracy and related skills[2]. Since then, there has been an ongoing discussion over whether a male advantage in these skills really exists. Advancing knowledge on this matter has been challenging given that the extent of the male advantage varies widely across studies, according to 'the nature of the cognitive task, the range of ability that was tested, the age and education of the participants and numerous other modifying and context variables' (Halpern 2012:

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[2] The literature cited in this section mainly focuses on gender differences in mathematical and spatial skills, rather than adult numeracy. As already mentioned, numeracy is distinct from mathematical and spatial skills. This literature is cited here because there is very little research on gender differences in adult numeracy specifically, therefore the research on gender and mathematical and spatial skills provides the main background to the topic. In this thesis, 'numeracy and related skills' is sometimes used as an umbrella term to encompass studies involving mathematical skills, quantitative reasoning skills, spatial skills, and numeracy.

375). Seeking to counteract the claim that women's under-representation in Science, Technology, Engineering, and Mathematics (STEM) is due to lower numerical ability (Frost et al. 1994; Spelke 2005; Hyde et al. 2008; Lindberg et al. 2010), some researchers have claimed that gender differences are too small to be practically important. However, in the past decade, studies have found sizeable and significant male advantages in numeracy and related skills in a range of age groups and country contexts, suggesting that this issue is worthy of further study (Bedard & Cho 2010; Lakin 2013; Dickerson et al. 2015; Makel et al. 2016; Contini et al. 2017; Gevrek et al. 2018; Rodríguez-Planas & Nollenberger 2018).

There is also evidence of gender disparities in skills related to numeracy, such as ICT. For example, some areas of ICT involve spatial skills, an aspect of numeracy. Studies in the 1980s and 1990s showed gender differences in both attitudes to ICT and skills in this area, suggesting a so-called gender digital divide (e.g. Reinen & Plomp 1997; Kirkpatrick & Cuban 1998). However, given the widespread proliferation of computer technology into everyday life, this gender divide is declining among younger generations. In the 2013 International Computer and Information Literacy Study of 14 year-olds' ICT competencies, girls in fact outperformed boys in most countries (Punter et al. 2017). However, males and females do have different interests, strengths, and habits when it comes to ICT (Ertl & Helling 2011; Joiner et al. 2015). These patterns may contribute to skill differences over time (Terlecki & Newcombe 2005). Moreover, the gender digital divide may have affected the numeracy and ICT skills of older generations of men and women.

While it seems that a male advantage on aspects of numeracy is widespread and enduring, the causes underlying this phenomenon are still unclear. Much research in this area takes place in psychology, wherein researchers focus primarily on individual-level processes (e.g. Ganley & Lubienski 2016) and have sometimes undertaken research using relatively small and unrepresentative samples. While psychological processes are undoubtedly important to explaining gender differences in skills, there is growing interest in clarifying the broader social processes reinforcing or reducing these disparities. With this aim in mind, scholars are turning to international comparisons, using nationally representative data from multiple countries to show that gender differences in numeracy and related skills are widespread, but also that certain features of societies are associated with their size. Examples of this international comparative approach include Guiso et al. (2008), Penner (2008); Bedard and Cho (2010), Lippa et al. (2010), Hoffman et al. (2011), Ayalon and Livneh (2013), Dickerson et al. (2015), and Gevrek et al. (2018).

1.1.3 Gender differences in adult numeracy

Notwithstanding the broadening scope of research into gender differences in numeracy and other cognitive skills, there is still a lack of focus on gender differences in numeracy among adults, with most studies focusing on children and adolescents. There are several reasons for this. Firstly, the literature on gender, numeracy and related skills is largely motivated by the agenda of increasing female participation in the STEM workforce. It is therefore focused on the early determinants of spatial skills and of high level skills in academic mathematics, which are thought to bolster future achievement in STEM (Levine et al. 2016). Secondly, adult numeracy is, in general, an 'under-theorised, under-researched and under-developed' area of research (Coben 2003: 7), since most of the scholarly interest is focused on early skill formation. Thirdly, good quality data on adult numeracy was not forthcoming until the recent undertaking of the OECD to study adult skills internationally with PIAAC[3].

There has been some exploration of gender differences in adult numeracy to date using PIAAC. For example, the OECD's main report on the PIAAC results (OECD 2013a) gives average gender differences

[3] Other international skills adult skills surveys (for example, The International Adult Literacy Study (IALS) and the Adult Literacy and Life Skills survey (ALL) were conducted in the 1990s and 2000s. As well as being more up-to-date, PIAAC represents a substantial improvement on these studies from a methodological point of view. This is discussed in more depth in Chapter 2.

in adult numeracy, while a subsequent report on gender and education (OECD 2015) gives average differences and differences at high and low percentiles for young adults aged 16-29. Both reports note the general conclusion that men's scores are generally higher than women's across countries, with cross-country variation. Some possible reasons for the emergence of gender differences in adult numeracy are suggested (the role of gender stereotypes and labour force participation, and generational effects of educational exposure, for example). There has also been some subsequent analysis showing that women use numeracy skills to a lesser extent than men do (Lindemann 2015; Arora and Pawlowski 2017; Borgonovi et al. 2017). Gender differences across PIAAC skill areas have also been explored within individual countries – for example, Tverdostup and Paas (2017) on Estonia. However, overall, this work has not analysed the differences in great depth or presented coherent or convincing hypotheses regarding the emergence of gender differences in adult numeracy and their cross-national variation. This thesis therefore builds on these past studies to go deeper into the topic, focusing in particular on age-group variation, distributional variation, potential reasons behind gender differences in adult numeracy skills, and their cross-national variation.

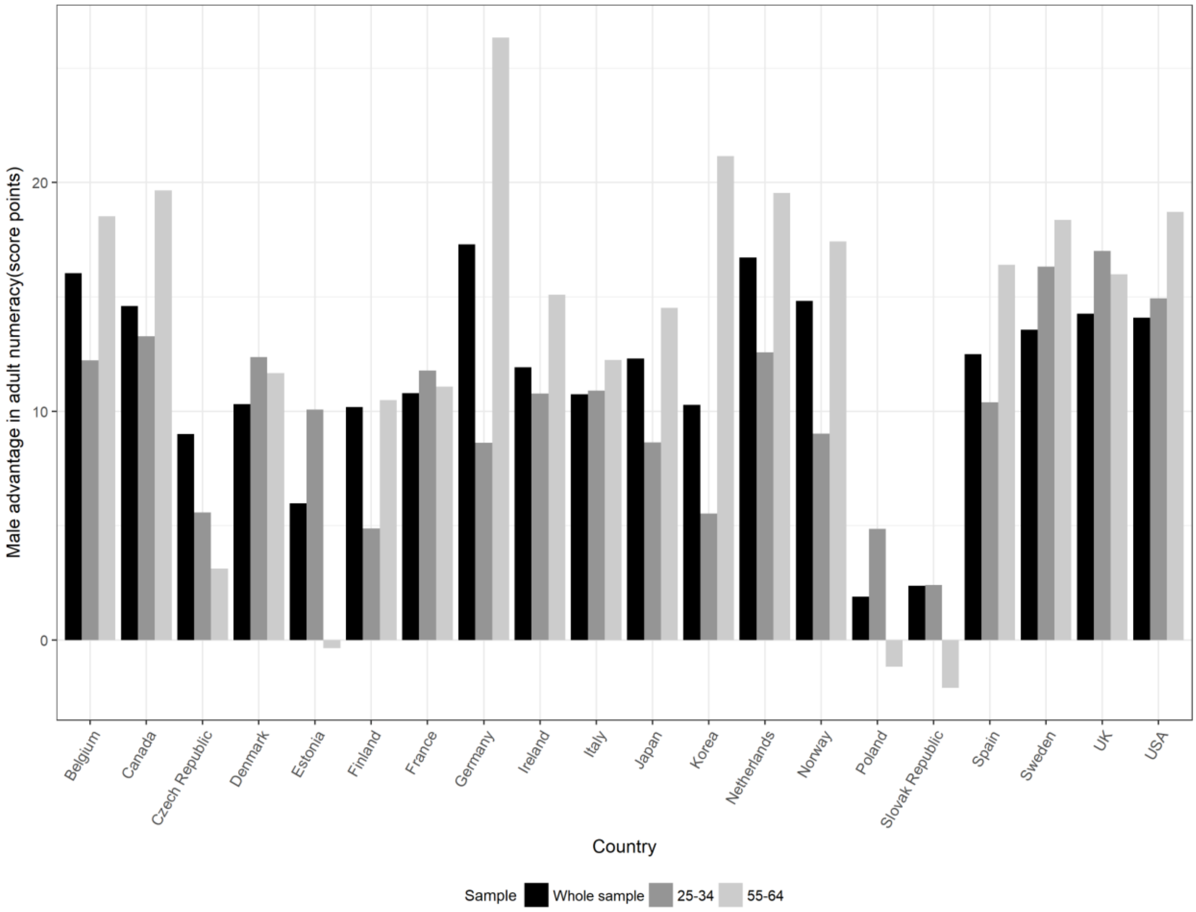
Figure 1.1 shows the gender difference in adult numeracy in the 20 countries included in the main empirical analysis in this thesis. The difference is displayed as the male advantage in average numeracy score points, calculated by subtracting women's average scores from men's in each country for three analytical samples: all adults aged 16–65; 25–34-year-olds and 55–64-year-olds. To put these differences in context, the PIAAC numeracy score has a mean of approximately 266 and standard deviation of approximately 54 across participating OECD countries (OECD 2013a: Table A2.6b)[4]. Figure 1.1 shows that the male advantage in adult numeracy is a widespread phenomenon across countries, among both younger adults (aged 25–34 in 2012) and older adults (aged 55–64 in 2012). However,

[4] Score differences are expressed as effect sizes where possible in the rest of the thesis.

the size of the male advantage varies in magnitude across countries and across age groups. For example, there are clear generational differences in the size of the gender difference in Germany, Korea, and Norway, where the difference is far larger among older than younger adults. In contrast, the male advantage is similar among younger and older adults in countries such as Sweden, the UK, and Denmark. There is also a slight female advantage in adult numeracy among older adults in Poland and the Slovak Republic. The graph therefore illustrates the variation in the size of the gender difference in adult numeracy across age groups and countries. Understanding this variation is one of the primary motivations of this thesis.

It is important to acknowledge that comparisons of gender differences across age groups are not straightforward, given the cross-sectional nature of the PIAAC data. Age group differences measured at a single point in time combine age effects – for example, the effect of biological ageing and changing experiences over the individual life course – as well as cohort effects, resulting from being born at a particular point in time, and thus being exposed to a different historical and policy context, including the education system. Age group differences may also reflect period effects, influences that result from measurement at a specific point in time. Since it is not possible to separate these effects using cross-sectional data (Hobcraft et al. 1985; Winship and Harding 2008), age group variation in the gender difference in adult numeracy should accordingly be read as a description of age differences between individuals at one period in time (Paccagnella 2016: 10). There is further discussion of this important issue in Chapters 2, 3 and 4. These chapters note that age group patterns in the gender difference in adult numeracy are most likely to reflect cohort effects, since there is no empirical evidence that men and women's numerical abilities age at different rates or to different extents (Meinz & Salthouse 1998; Aartsen et al. 2003).

Figure 1.1 Male advantage in adult numeracy: all adults (aged 16–65), younger adults (aged 25–34), and older adults (aged 55–64), PIAAC 2012



Source: Author's calculation using the PIAAC dataset. Results pooled across 20 countries. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.[5]

1.1.4 Why do gender differences in adult numeracy matter?

The relevance of studying gender differences in adult numeracy can be summarised with three main arguments. These are: the economic value of adult numeracy to societies and individuals; the social

[5] PIAAC numeracy scores are based on a plausible values methodology, which is described in section 2.4.1. PIAAC also uses a sampling method developed for complex surveys to account for sampling variation, known as Jackknife Replicate Weighting. The approach is described in Rust and Rao (1996). Like most surveys, PIAAC also incorporates sampling weights which are used to account for individuals' probability of selection into the sample. Across the thesis, results are combined across plausible values and these two categories of weights are used. This is noted beneath figures where relevant.

value of numeracy to societies and individuals; and the broader context of gender and education in industrialised societies.

The economic value of adult numeracy to societies and individuals

According to the theory of 'skills biased technological change' (Murnane et al. 1995; Levy 2010), post-industrial economies are increasingly reliant on the cognitive skills of the population to remain viable. There is empirical evidence showing that nations with high levels of adult numeracy in the population are more economically prosperous and more equal (Van Damme 2014). Numeracy is particularly necessary for the development and sustainability of an effective STEM sector, since it supports scientific research and innovation (Toner 2011; Desjardins et al. 2016). For example, the UK government has identified as 'growth sectors' numeracy-intensive industries including advanced manufacturing, low carbon industries, and life sciences (UK Commission for Employment and Skills 2011). Low numeracy skills among women therefore represent an imperfect use of potential human resources for the aims of innovation, progress, and prosperity.

Beyond the benefits of a higher level and more evenly distributed stock of numeracy skills at the population level, there is a growing consensus that cognitive skills, in combination with 'non-cognitive' traits (such as self-control) are linked to a wide range of positive individual outcomes (e.g. Heckman et al. 2006). Numeracy skills in particular are strongly associated with better employment opportunities (Rivera-Batiz 1992) and higher income (Vignoles et al. 2011; Hanushek et al. 2015). Gender differences in adult numeracy may also be partly responsible for unequal economic outcomes between men and women. Hanushek et al. (2015) found that one fifth of the gender wage gap in countries participating in PIAAC could be attributed to the male advantage in adult numeracy. There is also evidence that adult numeracy is especially important for women's employment outcomes (Parsons & Bynner 2005; Büchner et al. 2012). Investigating gender differences in adult numeracy and understanding the underlying reasons for this phenomenon could therefore help to clarify some of the broader drivers of continuing economic inequality between men and women.

The social value of numeracy to societies and individuals

Beyond employment and income, numeracy skills are linked to a range of other positive outcomes in adulthood, including financial literacy (Lusardi 2012) and health and wellbeing (Coben 2003; Sabates & Parsons 2012). A basic familiarity with numbers and an application of probabilistic reasoning is increasingly important for participation in civic life, due to the information rich societies we live in (Gal 2002; PIAAC Numeracy Expert Group 2009). As summarised by Bynner and Parsons (2009), basic skills, including numeracy:

> …play a key part in the essential competencies and capabilities that define positive career paths and trajectories through the various stages of life. Those without them are most likely to be found on a social exclusion path (p. 53)

Therefore, from a social justice point of view, gender disparities in adult numeracy are important because of their potential to induce gender inequalities in a range of domains, including employment, health, financial management, and civic engagement.

The broader context of gender and education in industrialised societies

Gender differences in adult numeracy are an interesting anomaly alongside other trends that have been highlighted within the literature on gender and education. For the past couple of decades, the most prominent and commonly discussed trend in this area has been the global 'rise of women' – the huge increases in educational participation and achievement among women over the course of the 20th and 21st centuries. This has been documented by numerous studies which cite increased incentives and returns to education, changes in family formation patterns, and changing gender norms as driving factors (Buchmann & DiPrete 2006; Vincent-Lancrin 2008; Pekkarinen 2012; UNESCO 2012b;

McDaniel 2012; DiPrete & Buchmann 2013; Fortin et al. 2015). Girls also appear to be performing better overall than boys in standardised tests of secondary school achievement in the US and UK (Machin & McNally 2005; Voyer & Voyer 2014; Fortin et al. 2015) and their reading and overall performance is better than boys' in the majority of countries taking part in the Programme for International Student Assessment (PISA) (Machin & Pekkarinen 2008; OECD 2016). Against this background, it is striking that women, particularly younger women, who are increasingly better educated, should still fall behind men in numeracy, a key skill for life and work in the contemporary world.

In summary, adult numeracy is important to individuals and to societies. Low numeracy among women represents a waste of potential human resources, as well as contributing to broader gender inequalities. Gender differences in numeracy are also difficult to explain alongside women's great advances in education more generally. However, beyond these important considerations, a further motivation for studying gender differences in adult numeracy lies in the deficiencies of the current literature and the lack of a coherent theoretical framework to explain the emergence, development, and maintenance of gender differences in adult numeracy in different country contexts.

The following section describes the alternative theoretical framework I have devised to address some of these deficiencies. This framework brings together insights from life course research on the determinants of skills in adult life, and feminist theory of gender relations. The two core expectations of this framework are (1) gender differences in adult numeracy are related to gender-differentiated experiences in adulthood, which operate over and above earlier educational experiences and other aspects of upbringing and (2) gender differences in adult numeracy are associated with patterns of gender relations at the national level. Following Connell (1987) and Connell and Pearse (2015), gender relations are conceptualised as configurations of social structure that encompass the gendered division of labour, the gendered division of power, and gender culture.

The next section starts with a brief overview of the epistemological foundations of the framework; specifically, its social constructionist interpretation of gender differences in adult numeracy. I then briefly outline the life course perspective on skill formation, which provides a further foundation for studying skill differences in adults. Following this, I describe the concept of gender relations and how it may help explain gender differences in adult numeracy at both the individual and societal level. I summarise the main expectations of the theoretical framework and highlight the empirical gaps to be filled by the thesis, before re-iterating how the thesis intends to contribute to knowledge on gender differences in numeracy and their expression in adulthood.

1.2 Integrative theoretical framework for explaining gender differences in adult numeracy

1.2.1 Nature or nurture?

In discussions of gender differences in traits, abilities, or characteristics, the focus inevitably shifts to the question: nature or nurture? The 'innateness' of gender differences in numeracy was brought to the fore once more in 2005 when, in a widely publicised speech, Harvard President Larry Summers said:

> … in the special case of science and engineering, there are issues of intrinsic aptitude, and particularly of the variability of aptitude, and that those considerations are reinforced by what are in fact lesser factors involving socialization and continuing discrimination. (Summers 2005)

Summers' statement, particularly the phrase 'intrinsic aptitude', summarises the perspective of a significant number of scholars, who propose genetic and evolutionary bases for gender differences in cognitive skills (e.g. Geary 1995; Baron-Cohen 2004). This 'master narrative' of gender differences (Epstein 2007) has been remarkably resilient, fuelling the controversy which has contributed to popularising research on gender differences in the social and biological sciences (Connell 2005; Epstein 2007; Halpern 2012).

In contrast to this perspective, this thesis adopts a social constructionist, or anti-essentialist standpoint (Sayer 1997) on gender differences, prioritising explanations involving, to use Summers' phrase, 'socialisation and continuing discrimination'. This social constructionist perspective on gender differences in sociology submits that 'sex' refers to biological features of male and female bodies, while 'gender' denotes the traits and characteristics associated with men and women, which are learned and acquired through social interaction (Oakley 1972; Butler 2004). Moreover, the designation of human traits as 'masculine' or 'feminine' is socially and historically specific, rather than universal and timeless (Connell 1987).

As well as being motivated by sociological theory, the applicability of the social constructionist perspective to gender differences in numeracy is supported by some empirical regularities. Firstly, there is evidence that both men and women are able to acquire specific numeracy skills that often exhibit a large male advantage when tested, such as spatial skills (Uttal et al. 2013). This suggests that gender differences arise from different levels of exposure and training, as opposed to innate dispositions. Secondly, as already noted, there is significant variation across societies in the gender difference in numeracy and related skills. This suggests that gender socialisation experiences and social structures that vary across societies play a role in the emergence and perpetuation of gender differences. The third piece of evidence supporting the social constructionist perspective is that gender differences in some aspects of numeracy appear to emerge *only* in adolescence and adulthood (Hyde et al. 1990; Voyer et al. 1995). This suggests the relevance of increasing exposure to gender socialisation experiences across the life course, including in adult life[6].

[6] Psychologists have also suggested that gender differences in skills are influenced by complex interactions between genetic, biological, and social factors (Halpern's 2012 'biopsychosocial' model). Although mindful of these developments, this thesis focuses on gender socialisation experiences and structural gender inequalities as the key explanation for gender differences in adult numeracy. For reviews of the research on biological and

1.2.2 Life course perspective on skill formation and gender differences in adult numeracy

In this thesis, the life course perspective on skill formation provides the backdrop to a consideration of the factors affecting gender differences in numeracy skills in adulthood. The inter-disciplinary field of life course studies submits that individual outcomes (across health, education, and economic life) result from interactive influences across the entire life course. These influences span genetic inheritance, the intrauterine environment, early childhood, adolescence, and adulthood (Elder 1985; Baltes 1987; Richards & Hatch 2011). Each of these life stages can be studied as a distinct link in the chain of human development. In sociology, life course studies are focused not only on individual development but also on individuals' interaction with social structures across each stage (Mayer 2003, 2004). A life course perspective on the development of gender differences in cognitive skills suggests that they can arise from complex interactions between individual characteristics and social structure across the life course (Schoon & Eccles 2014).

A mainstay of the life course approach is establishing the lasting influence of early experiences. It is undeniable that early childhood is the most important period for the acquisition of cognitive skills, with all later skill development building on this critical period (e.g. Heckman 2006). Indeed, cognitive ability in childhood correlates highly with cognitive ability in midlife and old age (Deary et al. 2000; Richards & Sacker 2003). Material conditions and socialisation experiences in childhood also have a lasting impact on skills in adulthood (Bynner & Parsons 1998; Richards & Sacker 2003). Gender differences in numeracy skills in adulthood may thus reflect gender differences in skills that have formed much earlier. Indeed, there is evidence that gender differences in numeracy and related skills are present among infants (e.g. Penner & Paret 2008; Quinn & Liben 2014). In addition, adolescence

genetic influences on gender differences in numeracy and related skills, readers can refer to Halpern (2012) and Levine et al. (2016).

is a critical period for gender socialisation and identity formation, in which individuals develop various gender stereotypical traits and characteristics (Eccles et al. 1990).

While emphasising the importance of early childhood and adolescence for explaining the level and distribution of cognitive skills in adults, a life course perspective also views skill development as a life-long process. In this way, skills such as numeracy are not simply a reflection of earlier-established cognitive potential but are malleable in adulthood. Overall, proficiency in all cognitive skills declines with age (Willms & Murray 2007; Desjardins & Warnke 2012). However, this decline will occur at different rates across individuals, and adults can learn and strengthen basic skills in numerous and varied contexts over their lifetime. Exposure to environments that promote the maintenance and further development of numeracy skills in adulthood can lead to the consolidation of existing skills, as well as the acquisition of new skills, while being absent from these environments can lead to more rapid skills loss, decline, or obsolescence (Desjardins & Warnke 2012). This perspective is supported by psychological theories of the learning process. For example, social learning theory suggests that learning occurs through interaction with the social environment throughout life (Bandura 1986), while practice engagement theory submits that skill maintenance in adulthood is related to engagement in 'life-long and life-wide' skills-related practices (Smith & Marsiske 1994; Reder 1994). If men engage more than women in 'life-long and life-wide' numeracy-related practices, this may be one reason their adult numeracy is better than that of women.

I have argued that there are good theoretical reasons to expect that experiences in adulthood may influence why men tend to have better numeracy skills than women. However, there is also empirical evidence to support this perspective. This evidence is drawn from studies of adults' basic skills, using data from large cohort studies, and other smaller longitudinal datasets. These studies have shown that skills in adulthood are not necessarily explained by skills measured earlier in life. Moreover, adults' skills develop over time in heterogeneous ways, depending on their experiences. For example, a longitudinal study of adult literacy and numeracy by Reder (2009) showed that some adults improve their skills over time, while other adults lose skills, and others change relatively little. This suggests that life experiences in adulthood are likely to influence skills and may inform gendered patterns of adult numeracy proficiency.

Some of the best evidence on adults' skills comes from the British cohort studies, principally the 1958 National Child Development Study and the 1970 British Cohort Study[7]. Analysis of these data underscores the critical importance of early childhood for explaining cognitive skills in adulthood. Factors measured in early childhood, such as higher social class and parental education, living conditions and parental involvement in schooling predict higher levels of adult numeracy. Scores on mathematics tests at age 7, 11, and 16 are also related to adult numeracy skills, suggesting a continuity of skills across the life course, even when taking into account a range of educational and labour market factors (Bynner & Parsons 1998).

However, early life and skills measured at ages 7, 11, and 16 do not explain all of the variation in adult numeracy – 60% remains unexplained at age 34 (Bynner & Parsons 2009). This suggests that a large proportion of the variation in numeracy can be explained by adult life experience (as well as unmeasured factors). Variables independently associated with numeracy in adulthood are: highest qualification at age 23, work-related training, and time spent in employment. Bynner and Parsons' analysis did not explore occupations. It therefore follows that gender differences in any of these areas (education, training, and employment) could induce gender differences in numeracy.

[7] The measures of numeracy included in the 1958 cohort and 1970 cohort studies are different from those used in PIAAC. The assessments attempt to capture more basic numeracy skills and are less extensive and detailed than the PIAAC assessment. They were also conducted only with specific cohorts of adults in Britain at specific time points (in 1995 for the 1958 cohort and in 2004 for the 1970 cohort). Therefore, the results from these studies are not directly transferable to adults participating in PIAAC. However, these studies provide some of the only evidence available on numeracy skills in adults and are thus a crucial source of information for the development of the theoretical framework.

Although longitudinal analyses of the British cohort studies were not focused on explaining gender differences, they can be used to deduce some of the life course factors that are associated with the gender difference. Table 1.1 is a reproduction of the results of a regression model developed by Bynner and Parsons (1998) to explain British adults' numeracy levels at age 37 as a function of influences across the life course.

Table 1.1 Early predictors of adult numeracy – adapted from Bynner and Parsons (1998)

Model	1	2	3	4	5	6	7	8	9	10
Sex (male)	**.14**	**.15**	**.15**	**.15**	**.14**	**.13**	**.11**	**.12**	**.11**	**.11**
Age mother left full-time education		.15	.14	.13	.10	.06	.03	.03	.01	.00
Mother read to child			.09	.10	.10	.08	.07	.06	.06.	06
Draw-a-man test at 7				.22	.14	.07	.07	.06	.06	.06
Maths test at 7					.28	.10	.07	.07	.07	.06
Maths test at 11						.42	.28	.25	.23	.22
Maths test at 16							.25	.21	.18	.18
Exam score at 16								.12	.07	.05
Highest qualification at 23									.16	.07
Highest qualification at 33										.13
R squared	.02	.04	.05	.10	.17	.29	.33	.34	.36	.36

Source: National Child Development Study (1958 cohort), analysis by Bynner and Parsons (1998) (Table 6.2b).

The gender difference in numeracy is indicated in the first row of the table; this gender coefficient equates to a standardised difference between male and female average scores on the adult numeracy assessment at age 37. It is shown to be 0.14 without any other variables considered. This gender difference does not reduce when including factors such as mother's education, whether the individual was read to as a child, and early skills tests. In view of maths test scores at ages 7 and 11, the gender difference reduces slightly, showing that gender differences in early maths skills can partly account for the adult gender difference. The gender difference remains at 0.11 in Model 10, even after including all of the factors measured earlier in the life course. This suggests that the gender difference in numeracy must be explained by other factors, either unmeasured factors from earlier in the life course, or differences in adult experiences.

Although this analysis is very revealing of the explanations behind gender differences in adult numeracy, it is not focused explicitly in explaining this difference. This individual level analysis in this thesis therefore builds on the studies of Bynner and Parsons to explore in greater detail the educational influences on the gender difference in adult numeracy, zoning in on post-compulsory education, and on gender differences in fields of study. It also explores the influence of gender differences in labour market experiences and national-level gender relations.

As a cross-sectional analysis, it will not be possible to include the rich life course controls that are available in the British cohort studies dat. As such, the analysis in this thesis does not reflect a classical life course approach and cannot definitively separate cohort and life course effects in the way that is possible using longitudinal data. However, Table 1.1 suggests that earlier measured scores on mathematics tests were not an overwhelmingly large influence on the gender difference in adulthood, which remained present despite these controls. Therefore, although the present study is limited by not considering earlier measured ability and skills, Figure 1.1 provides some reassurance that this bias is not too large.

To summarise, the life course perspective on adult skills provides a useful backdrop to the present thesis, since it suggests that gender differences in adult numeracy are likely to be related to experiences taking place in adulthood, over and above earlier experiences. The next section explores which aspects of adult life are likely to be particularly important in order to set up the analytical strategy pursued in this thesis.

1.2.3 Gender inequality and gender differences in numeracy

A central idea in the literature to date is that gender differences in numeracy and related skills could be related to gender (in)equality. The 'gender stratification hypothesis' (Baker & Jones 1993) suggests that the male advantage in numeracy and related skills is mainly a product of male advantages in education, the labour market, and other areas of public life. This leads to the prediction that the male advantage should decline as gender parity in these spheres is achieved. In line with this hypothesis, subsequent US research suggested that the gender gap in mathematics achievement has been decreasing over time, alongside women's increasing educational participation (Brody & Mills 2005; Hyde et al. 2008; Wai et al. 2010; Kane & Mertz 2012). Gender differences were also shown to be smaller in countries where women have more access to education, the labour market and positions of power in society, as measured by composite indicators of gender inequality such as the Gender Empowerment Measure (GEM) and the Gender Gap Index (GGI) (Baker & Jones 1993; Riegle-Crumb 2005; Guiso et al. 2008; Else-Quest et al. 2010).

However, other research, using broader samples of countries and different sets of control variables, has been unable to replicate these findings. In these studies, the gender difference in mathematics appears to be smallest in countries with high levels of gender inequality, such as Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia (Ellison & Swanson 2010; Fryer & Levitt 2010). Moreover, there are also some contradictory or unexpected findings. For example, in research using 1995 Trends in International Mathematics and Science Study (TIMSS), Penner (2008) finds a larger male advantage in mathematics achievement in countries with relatively high levels of female labour force participation, a key indicator of gender equality. Meanwhile, other studies find weak, inconsistent, or null relationships between composite measures of gender (in)equality and gender differences in PISA mathematics, in term of both average scores and score variance (Machin & Pekkarinen 2008; Stoet & Reilly 2012; Geary 2015; Ireson 2017; Tao & Michalopoulos 2018).

Therefore, in some studies, it seems that gender differences in numeracy and related skills are associated with gender inequality. In other studies, it seems they are not. There are many potential reasons for these inconsistencies, not least methodological differences. However, in this thesis, I wish to argue that the way these studies have conceptualised 'gender inequality' is problematic, and that this is partly what has led to contradictory findings. These studies also offer a narrow perspective on how gender inequality affects the realisation of cognitive skills among men and women. I propose that the concept of gender relations, derived from feminist perspectives on the multidimensional, complex, and pervasive nature of gender inequality, is a more useful way to frame the effects of adulthood experiences and exposures on gender differences in numeracy.

'Gender relations' can be broadly defined as the ways that people, groups and organisations are connected and divided on the basis of gender (Connell & Pearse 2015). Gender relations are an aspect of social structure, or a social institution (Martin 2004), yet they hinge on individual actions. For example, people perform gendered behaviour in many locations including on the street, in homes and workplaces. These individual actions in varied contexts accumulate to constitute gender relations, a set of social relationships which combine in enduring patterns to create the social structures of gender (Connell 1987; West & Zimmerman 1987; Acker 1990; Ridgeway & Smith-Lovin 1999; Martin 2004).

The main way in which the concept of gender relations is useful for the purposes of this thesis is that it poses relations between the genders as inherently multidimensional. In previous comparative studies of gender and numeracy, gender equality has been conceptualised and measured on a continuum, from 'inegalitarian' to 'egalitarian', either by using composite indicators (e.g. Guiso et al. 2008; Gevrek et al. 2018), or by focusing on single indicators, such as gender role attitudes (Rodríguez-Planas & Nollenberger 2018). To improve on these conceptualisations of gender inequality, I draw primarily upon Raewyn Connell's (1987) theory of gender relations. In *Gender and Power* (1987), Connell suggested that gender relations are composed of three independently varying structures: the division of labour (including the gender division of both unpaid and paid labour, and segregation in the labour market); the division of power (authority, control, and coercion); and cathexis, constraints on interpersonal and emotional relationships. On each dimension, one can trace examples within institutions, the family, culture, workplaces, and so on. Distinctions between ‘horizontal’ and ‘vertical’ inequalities also hinge on the idea of gender inequalities being multidimensional. Vertical inequalities refer to divisions between men and women in terms of status, power or prestige, while horizontal inequalities refer to more qualitative differences in men and women’s (usually economic) roles (Charles and Grusky 2004; Semuonov & Jones 1999).

Once we acknowledge that gender relations are multidimensional, it becomes possible to understand the tensions and inconsistencies present in contemporary, industrialised societies. For example, the modern liberal state defines men and women as citizens with the opportunity to study and earn a living, therefore equal. Societies are effectively ranked in this respect with commonly used unidimensional measures such as the Gender Empowerment Measure (GGM) and Gender Gap Index (GGI), since these measures are focused on access to resources and opportunities in the public domain. However, once we incorporate divisions of labour within the workplace and in the household, and gender role attitudes within the broader culture, it is clear that, even in contexts where women are empowered, many divisions still exist. Viewing gender relations as multidimensional thereby draws attention to the marked gender inequalities that still exist to varying extents in post-industrial societies, most notably, women’s continued responsibility for the majority of household labour, and the gender segregation of employment (e.g. England 2010; Charles 2011). A multidimensional perspective also allows one to trace connections between different dimensions of gender relations. For example, cultural models of gender underpin different divisions of labour (Pfau-Effinger 1998), while the division of labour contributes to the bolstering of the gender division of power through male monopoly of the most powerful forms of employment, for example, in management, government and law.

Another key aspect of gender relations is that the various dimensions can operate at both the individual level, within societies, as well as combining to create a complex pattern of gender relations at the societal level. My approach therefore proposes that gender relations are inherently 'integrative', encompassing the ways gender is realised on both the individual and collective level (e.g. Blumberg 1984; Fuwa 2004). Gender differences in adult numeracy could be a function of inequalities at the individual level, in addition to macro-level gender relations. The gender relations concept therefore provides a way to frame the decomposition of the analysis in this thesis to the individual level (chapters 4 and 5) and the collective level (Chapter 6). By decomposing gender relations and their effects into individual and collective components, my approach facilitates identification of where action should be directed in order to minimise gender differences in adult numeracy. For example, would changes in the circumstances of individual men and women lead to an equalisation of adult numeracy? Would change at the societal level be needed? Or both?

1.2.4 Individual-level explanations

Earlier in this chapter I suggested that men and women may be differentially exposed to environments that promote the maintenance and further development of adult numeracy. The aim of the individual-level analyses in chapters 4 and 5 is to uncover which aspects of individual-level gender difference and inequality are relevant to explaining why men have better numeracy skills than women in most societies under study. I aim to identify whether, and to what extent, the gender division of power and the gender division of labour *within* societies is related to the gender difference in adult numeracy, focusing on the realms of education and work.

Education

There is a strong relationship between educational attainment and adult numeracy (Bynner & Parsons 1998; OECD 2013a). For example, in Bynner and Parsons' longitudinal study of the influences on adult numeracy among British adults, individuals' highest qualification by age 23 was significantly associated with scores on a numeracy test at age 37. This suggests that adults with higher levels of educational attainment are likely to have had more exposure to the types of experiences that help to develop and maintain numeracy skills. Education includes specific training in numeracy, and exposure to an environment in which numeracy is relevant to everyday tasks. Education also gives adults access to better quality jobs in which numeracy skills are required and used, thus enabling them to maintain and further develop their skills. Education can therefore be viewed as a strategic resource which promotes the acquisition and maintenance of adult numeracy.

Gender inequalities in access to education are an important aspect of the gendered division of power, since they introduce inequalities of access to scarce and valued resources and opportunities (Chafetz 1988). Therefore, by analysing whether gender differences in educational attainment explain gender differences in numeracy, we can assess whether this type of uneven distribution of power and opportunities is salient. The results will suggest whether, if individual women improve their educational attainment, their adult numeracy is likely to be more equal to men's.

However, in contemporary post-industrial societies, the relationship between gender and education is complex and multi-layered. In many societies, including those under study in this thesis, there have been huge increases in educational participation and achievement among women over the course of the 20th and 21st centuries (DiPrete & Buchmann 2013). However, although the 'gender revolution' in education is now a global phenomenon (McDaniel 2012), the timing and rate of change vary across contexts. For example, in countries like the US and UK, the mass expansion and mass entry of women into higher education began several decades ago, whereas in a country like South Korea, these processes have taken place more recently. It is therefore too simplistic to analyse the role of 'gender equality in education' as a contemporary phenomenon. Gender inequalities in educational attainment exist to different extents across age groups and countries. The chapter therefore assesses the role of educational attainment for explaining numeracy skill differences in a range of country-age groups with different educational exposures in different systems of education.

In the context of high educational participation among women, other aspects of gender differentiation within education may be important for explaining gender differences in adult numeracy. For example, men and women typically study different subjects in further and higher education. These divisions are often closely aligned with the division of labour in the broader society. Women tend to study female-typical fields, such as teaching and humanities, while men are much more likely to study scientific and technical subjects (Jacobs 1996; Bradley 2000; Smyth & Steinmetz 2008; Charles & Bradley 2009; Barone 2011). This may equip them with different skillsets and lead them to pursue different careers. Therefore, in Chapter 4, the focus is also on establishing which fields of study are more strongly associated with adult numeracy, and how the gender distribution across these fields of study might affect gender differences in adult numeracy in the adult population. Field of study is contrasted with educational attainment to evaluate which variable is more pertinent to explaining gender differences in adult numeracy in two generations of adults across countries. In this way, Chapter 4 examines how divisions of power and divisions of labour within the educational realm (as expressions of gender relations at the individual level) contribute to gender differences in adult numeracy.

The workplace

Exposure to contexts that promote the maintenance and further development of numeracy in adulthood can lead to the consolidation of existing skills, as well as the acquisition of new skills, while being absent from these environments can lead to more rapid skills loss, decline, or obsolescence (Desjardins & Warnke 2012). For most adults, the main context in which skills are developed and maintained is the workplace. For example, the qualities of occupations are likely to regulate the extent and intensity of skills use at work. Through their work, some individuals have more opportunity to maintain and develop skills than others (Richards & Deary 2005; Richards & Hatch 2011; Desjardins &

Warnke 2012;). While this argument applies to all cognitive skills, there is some evidence to suggest that work and its qualities may be particularly important for the maintenance and development of adult numeracy (Bynner & Parsons 1997b, 2009; Parsons & Bynner 2005).

Employment is another arena in which men and women have increasingly equal access, but in the form of highly gender-differentiated roles (Charles 2011). Women's share of the labour force has increased dramatically in recent decades. Through equal access to the cognitively stimulating environment of work, one may expect skill differences between men and women to decline. But despite increasingly equal access, men and women inhabit very different roles within the paid labour force. Across industrialised countries, the gender segregation of occupations is extremely marked (Charles & Grusky 2004; Charles 2011), giving rise to a gendered division of labour that reflects stereotypical assumptions about men and women's abilities as well as male domination of more powerful and high status areas of the labour market.

On the one hand, changes in the occupational structure, combined with women's increasing education levels, have enabled women to access a growing range of occupations (Scott et al. 2008; Webb 2009), including those requiring relatively high levels of skill and education, for example, managers and administrators, professional occupations, and associate professional and technical occupations. Many skilled jobs, such as teaching, are female-dominated, and women predominate among clerks and service workers, which are likely to have a higher skill content than many male-dominated, manual occupations (for example, agriculture, crafts, and machinery operators). However, across industrialised societies, women dominate parts of the economy that tend to be more 'family-friendly', yet less well rewarded in terms of pay, job authority, and job quality (e.g. Mandel & Semyonov 2006).

The idea that men's and women's working lives may affect their relative levels of adult numeracy is explored empirically in Chapter 5, which uses the rich data on skills use from PIAAC to characterise occupations in terms of their 'numeracy-intensiveness' and evaluates to what extent this 'numeracy-intensiveness' is unevenly distributed by gender. This analysis builds on previous evidence from PIAAC suggesting that women use numeracy skills less than men do in the workplace (Lindemann, 2015; Borgonovi et al. 2017). In doing so, it evaluates whether the gender segregation of employment, an aspect of the gender division of labour within societies, is related to gender differences in adult numeracy.

1.2.5 Contextual analysis

Although the general trend across societies is for men to be more numerate than their female counterparts, the size and strength of the difference varies (see Figure 1.1). This suggests that features of societies may encourage or inhibit the male advantage. Therefore, in addition to studying the role of aspects of gender relations at the individual level, one must also consider the role of country context. This is a key aspect of comparative sociological study: sociologists call for consideration of the social and cultural embeddedness of all social behaviour and social stratification processes (Granovetter 1985; Brinton 1988; Kerckhoff 1996; DiPrete & McManus 2000). This is particularly the case when studying gender differences and inequalities, for which societal context appears to be particularly crucial (e.g. Batalova & Cohen 2002; Fuwa 2004; Blossfeld & Hofmeister 2006; Blossfeld et al. 2015). The level and distribution of skills in the population are also strongly influenced by structural features of society relating to the economy and the labour market (Green 1992; Mayer & Solga 2008;).

The contextual analysis in Chapter 6 examines the proposition that gender differences in adult numeracy are related to gender relations at the societal level. It evaluates whether such a relationship can illuminate why the gender difference is larger in some countries than in others. However, rather than focusing on 'levels' or degrees of inequality, as in previous international studies of gender and numeracy, the chapter focuses on the varied ways in which societies structure gender, reflected in multiple indicators of gender relations. Although phenomena such as the 'gender revolution' in education are global in nature (McDaniel 2012), societies still vary greatly in terms of the gender division of positions of power in society (Wängnerud 2009), female labour force participation rates (Thévenon 2016) and gender role attitudes (Knight & Brinton 2017). Progress towards equality has been achieved at different rates for different indicators, and there is often a 'time lag' between structural changes and attitudinal ones (Seguino 2007; Inglehart et al. 2017; Sullivan et al. 2018). The unevenness of societal-level gender equality in industrialised societies suggests that relations between the genders at the societal level are more appropriately viewed as a configuration, with various conflicting and contradictory aspects (Connell 1987; Fraser 1994; Pfau-Effinger 1998; Chang 2000; Pfau-Effinger 2005; Mandel 2009). Societies can exhibit egalitarian and inegalitarian features simultaneously (Mandel 2009) and societies have 'different ways of structuring gender, reflecting the dominance of different social interests' (Connell 1987: 63). Chapter 6 therefore considers several aspects of societal gender inequality simultaneously, which measure the gendered division of labour, the gendered division of power, and gender culture.

A key issue within comparative sociology is the mechanisms explaining associations between national-level phenomena and individual-level outcomes (Goldthorpe 2016). Existing comparative studies on the links between gender equality at the national level and gender differences in skills largely conceptualise this in terms of 'empowerment'. They view gender equality in society as facilitating a sense of freedom and personal agency or mastery among girls (Else-Quest & Grabe 2012), leading them to make fewer gender-traditional educational choices. However, mechanisms are rarely interrogated further than this. These studies address skill development mainly as a matter of individual choice, and do not interrogate the assumption that numeracy skills are somehow inherently masculine. Moreover, this narrative cannot be expanded to account for why gender differences in skills persist in contexts where women are, by all accounts, 'empowered'.

Societal context is crucial not only for adherence to social norms; it also contributes to the constitution and development of social norms. For example, a 'culturalist' interpretation suggests that gender relations at the societal level, in particular gender segregation in employment, create norms about how men and women should behave. These norms contribute to the development of cultural scripts which inform individual men's and women's choices and behaviour, including the way they 'do gender' (West & Zimmerman 1987) through their educational and employment choices. In this view, gender differences in adult numeracy, particularly in societies where women are empowered in terms of their educational and employment opportunities, result mainly from individual choices (conscious or unconscious) and the enactment of gendered cultural scripts derived from the broader environment (Eagly & Wood 1999; Eagly et al. 2000).

On the other hand, 'structuralist' arguments suggest that gender relations at the societal level act as constraints on individual behaviour. In this view, institutional constraints are the main driver of gender differences in education and work domains (Reskin & Roos 1990; Reskin & Maroto 2011). Even where formal equality is institutionalised, the structure of institutions could prevent women from acquiring and maintaining numeracy skills, for example through hiring and recruitment practices which prevent them from entering numerate fields of education and employment, fewer opportunities for skill upgrading and training, and discrimination, both overt and covert (Weeden & Sorensen 2004; Scott et al. 2008; Reskin & Maroto 2011).

This thesis cannot empirically evaluate the precise mechanisms driving any associations between national gender relations and gender differences in numeracy. However, it is mindful of the foregoing considerations, expanding on them in chapters 6 and 7, and suggesting further research that could be undertaken to evaluate suggested mechanisms empirically. On balance, the structuralist approach is preferable due to its implications for policy and practice. An essentialist viewpoint suggests that gendered preferences are so deeply held by individuals and so embedded in liberal egalitarian ideology that it would take a cultural revolution to shift them (Charles & Grusky 2011). However, from a structuralist perspective, any potential link between gender relations and gender differences in adult numeracy would be amenable to policy and legal intervention. For example, male monopoly of numeracy-intensive occupations might be tackled through policies such as positive discrimination and segregation and hiring audits (Bettio et al. 2009).

1.3 Aims and research questions

The broad expectation of the theoretical framework is that the male advantage in adult numeracy is related to gender-differentiated experiences in adulthood, over and above earlier educational experiences and other aspects of upbringing. This expectation is motivated by a life course perspective on skill development, which suggests that skills such as numeracy are malleable in adulthood and are not simply a reflection of earlier-established cognitive potential. Tracing gender relations within societies, the individual-level analysis focuses on the role of stratification and segregation processes in education and the labour market and how these might influence the gender difference in adult numeracy. The framework further suggests that gender differences in adult numeracy are driven by the characteristics of societies, including different aspects of gender relations at the societal level.

Building on and critiquing the prior literature, the overarching aim of the thesis is to challenge and problematise the idea of a straightforward, linear relationship between gender inequality and gender differences in adult numeracy. This is achieved by decomposing the concept of ‘gender inequality’ into some of its constituent parts at both the individual and societal level and by analysing how these components are related to gender differences in adult numeracy.

The research questions this thesis aims to answer are:

(a) How can we understand the gender difference in adult numeracy?

The descriptive analysis in Chapter 3 asks broad questions about gender differences in adult numeracy – what are they, and what do they mean? The answers to these questions build on primarily descriptive analyses of the PIAAC data. The sub-questions below build upon existing studies of gender differences in numeracy and related skills, which suggest that age is an important factor to consider, alongside ample evidence that gender differences vary across the performance distribution, emerging mainly at higher levels of skill. However, departing from previous studies, this chapter provides evidence on these questions for representative samples of adults. The chapter specifies three sub-questions, A1 to A3:

A1: How large are gender differences in adult numeracy?

A2: How do gender differences in adult numeracy vary by age group?

A3: How do gender differences in adult numeracy vary across the performance distribution?

(b) How are gender differences in numeracy related to gender-differentiated educational experiences?

By providing an answer to this research question, Chapter 4 assesses the evidence in favour the gender stratification hypothesis, advanced in previous research. This hypothesis suggests that gender differences in numeracy and related skills can be explained by gender inequalities in education. This implies that gender differences in numeracy will have decreased over time, as education has become more gender-equal, and thus will be smaller among younger than older adults. To explore this proposition in detail, Chapter 4 specifies two sub-questions, B1 and B2:

B1: To what extent do gender differences in educational attainment explain gender differences in adult numeracy? How does this vary across countries and age groups?

B2: Can gender segregation of fields of study be considered a complementary mechanism sustaining gender differences in adult numeracy?

(c) How are gender differences in adult numeracy related to gender segregation in the labour market?

A further aim of the thesis is to better understand the relationship between labour market engagement and gender differences in adult numeracy. Noting that women's labour market engagement in industrialised countries is characterised by occupational segregation, Chapter 5 explores the role this segregation plays in relation to gender differences in adult numeracy. The chapter proposes that existing models for conceptualising and measuring occupational gender segregation would probably not capture the aspects of occupations that are most relevant to adult numeracy. Instead, an alternative empirical approach is developed, which classifies occupations in terms of their numeracy-intensiveness. The sub-questions based on this novel empirical approach are:

C1: Are women more likely than men to work in occupations that are low in numeracy-intensiveness?

C2: If so, can this explain their disadvantage in adult numeracy?

(d) How are gender differences in adult numeracy related to country-level gender relations?

The final research question addresses the country level of analysis and attempts to explain cross-national variation in the gender difference in adult numeracy. Chapter 6 analyses the remaining individual-level gender differences from each country as the outcome variable in a comparative analysis. The chapter uses the technique of cluster analysis to group countries on a range of theoretically relevant indicators of gender relations. It then compares these clusters to assess whether particular configurations of gender relations are associated with a smaller or larger gender difference in adult numeracy. By focusing on multidimensional gender relations, the chapter uses a more realistic conceptualisation of gender inequality that considers contradictory indicators and potential non-linear effects.

1.4 Contributions

The first major contribution of this thesis is new empirical analysis of PIAAC, addressing an important and relatively unexplored issue. The thesis contributes to knowledge on the determinants of adult numeracy, which is in general an under-developed area of research (Coben 2003). It does this using large-scale, nationally representative data, and direct measures of adult numeracy. Representative samples and direct measures of skills are key strengths when assessing population skill levels and differences. Using this robust approach, the thesis makes an important contribution to knowledge on tackling gender differences in skills in different OECD countries. Given the importance of skills in contemporary economies, inequalities in adult skills, including numeracy skills, have been identified as a major public policy issue and have been a central focus of research conducted using the PIAAC data since its release (Van Damme 2014; Green et al. 2015; Heisig & Solga 2015; Levels et al. 2017; Calero & Choi 2017; Borgna 2017; Dämmrich & Triventi 2018). However, despite their obvious importance, gender differences in PIAAC cognitive skills have received comparatively less attention (although see Arora and Pawlowski 2017; Borgonovi et al. 2017; OECD 2015). In light of the important considerations highlighted earlier in this introduction (the economic value of adult numeracy to societies and individuals, the social value of numeracy to societies and individuals, and the broader context of gender and education in industrialised societies) it is important to understand what is driving gender differences, alongside differences based on other social characteristics such as immigration background and socio-economic status.

In order to address the conundrums in the previous literature, described earlier in this chapter, the second contribution of the thesis is to synthesise areas of research that have rarely been brought together before, combining insights from life course research on the determinants of skills in adult life and feminist theory of gender relations. Drawing on knowledge from life course theory (Elder 1985), social epidemiology (e.g. Richards & Hatch 2011) and the British cohort studies (e.g. Bynner & Parsons 1998, 2005), I adopt the assumption that factors in adult life are influential for the maintenance and development of cognitive skills such as numeracy. This is an important assumption since it is often suggested that cognitive skills are fixed early in the life course.

While many empirical studies of gender differences in numeracy and related skills have incorporated indicators of gender inequality, they tend to be reductive and uncritical about the processes that connect the subordination of women to gender differences in numeracy and related skills. In contrast to previous studies, this thesis adopts a feminist approach, in that it views gender differences in numeracy as embedded in multidimensional gender relations and sustained by complex individual and societal processes. From feminist and sociological theory, I derive the proposition that gender relations should be viewed as a configuration, operating at multiple levels and often patterning in conflicting and multidimensional ways. I also touch upon the debate between 'culturalists' and 'structuralists' regarding the nature and effects of gender segregation in contemporary post-industrial societies. Given its broad approach, the findings from this thesis will be useful to academic researchers across a range of disciplines. This includes comparative education researchers, sociologists of education and work, comparative sociologists, and sociologists of gender.

While this study capitalises on the inherent strengths of the PIAAC data, it also uses the data in innovative ways to tackle the research questions, offering a novel methodological contribution to the literature on cross-national gender differences in skills. Firstly, throughout the thesis, I focus on the extremes of the adult numeracy distribution, at high and low skill levels, as well as analysing average differences. This provides a more well-rounded approach than simply focusing on average differences and builds on a strong tradition of assessing gender differences at distribution extremes. In Chapter 5, I use the rich data on skills use in the workplace, generated as part of the PIAAC background questionnaire, to develop a new measure of numeracy-intensiveness of occupations. These empirical measures are country-specific, rather than relying on assumptions about occupations that may not be universally applicable. The detailed approach allows an assessment of what in particular about gender segregation is instrumental for gender differences in adult numeracy. Finally, in Chapter 6, I use supplementary data from a range of sources to construct multidimensional clusters of gender relations. I then assess how these configurations are associated with gender differences in adult numeracy. While addressing gender relations as multidimensional and configurational is not new in comparative research (see Mandel 2009; Knight & Brinton 2017), to my knowledge it has not yet been used in relation to gender differences in cognitive skills.

Fourthly, the thesis also represents an improvement on the approach used in previous studies on gender and numeracy. Previous research has tended to focus either on the individual, or on macro-level processes. By addressing these levels in turn, the two-step methodological approach allows a decomposition of different components of gender relations, providing a cumulative analysis of their role in relation to gender differences in adult numeracy. This represents an empirical application of the idea that gender relations operate at multiple structural levels from the micro to the macro (Blumberg 1984; Fuwa 2004). The methodological approach is thereby not only original, but also closely aligned with the theoretical framework. The next chapter outlines this methodological approach in detail.

2. Methodology

2.1 Chapter outline

This chapter details and justifies the methodological decisions of the thesis. It starts in section 2.2 with a description of the research design. Section 2.3 describes the PIAAC data, detailing its advantages and limitations. This includes a discussion of the size and scope of the analysis, and a description of all supplementary data sources. Section 2.4 details the indicators used to measure key concepts. Section 2.5 describes the approach to handling missing data. Section 2.6 describes and justifies the thesis's chosen methods of analysis, including the statistical models used. Many methodological aspects are common or similar across empirical chapters, so to avoid repetition and save space, it is considered best to cover most methodological issues here, with brief reminders and elaborations where necessary in each empirical chapter. The limitations of the study's methodology are discussed in the conclusion.

2.2 Research design

The study presented in this thesis can be characterised as a large sample, comparative, variable-oriented quantitative investigation. It is large sample in that data on adults in 20 countries are included, with a total sample size of 143,492[8]. The analysis is concerned with explaining two types of variation. The first is variation in adult numeracy levels between men and women within countries. The second is variation across countries in the size of the country-specific gender difference. The investigation is variable-oriented, in that it focuses on exploring the relationship between variables, whose values are populated by individuals and countries. This is as opposed to a case-based approach,

[8] Total N before any age-group or other selections made.

another popular method of comparative analysis, which would provide a descriptive account of selected country cases (Hakim 1987).

Large sample, comparative, variable-oriented analysis is becoming very common in the social sciences, particularly in the fields of sociology, social policy, and education. This is partly due to the increasing availability of large-scale quantitative comparative data and its accessibility for public analysis. Quantitative comparative analysis is particularly useful for demonstrating the variability of social phenomena, for understanding the broader institutional context in which they are embedded, and for calling into question previously held assumptions. It has already been used to study gender differences in skills cross-nationally (for example, by Guiso et al. 2008, Penner 2008, Bedard and Cho 2010, Ayalon and Livneh 2013, and Gevrek et al. 2018).

This research design has a number of advantages. Large sample, comparative, variable-oriented analysis is also an effective research design for testing theory. For example, it can be used to test hypotheses about the relationship between variables by exploiting variation across countries, in a way that is not possible using a single data point. With this set-up, researchers implicitly suggest a counterfactual – that the presence or absence of a certain policy or phenomenon is related to a given outcome (Hantrais 2008). This is close to the experimental method – allowing researchers to control the variables making up a theoretical relationship and identifying necessary and sufficient conditions under which relationships occur (Hantrais 2008: 10). This hypothesis-testing procedure can be used to make and test predictions about the relationships between the variables of interest (Landman 2003; Hantrais 2008). The present thesis uses this aspect of the comparative method, in that it tests the relationships between gender relations and gender differences in adult numeracy, using the full range of variation available in the country sample. The idea that the determinants of the gender difference in numeracy in adulthood can be indexed by the presence and absence of certain conditions in the country cases is implicit in this method.

Large sample comparative studies can also be used to test the generalisability of a theory or hypothesis across multiple contexts. The present study uses a similar approach to compare the applicability of individual-level explanatory models of the gender difference in numeracy across different country contexts. For example, an established hypothesis in the literature is that the gender difference in numeracy is related to gender differences in educational attainment. The study tests whether this is the case across all countries (Chapter 4).

Large N, comparative, variable-oriented analysis can be used to make policy recommendations. For example, this set-up has been used to identify the fact that standardised education systems are more likely to promote equality of educational outcomes (e.g. Shavit & Blossfeld 1993; Van De Werfhorst & Mijs 2010). In this thesis, the aim is to identify aspects of countries' gender relations which can be empirically associated with higher or lower levels of gender differences in adult numeracy. These associations can be used to develop policy recommendations regarding educational and labour market practices that might be expected to reduce gender differences in adult numeracy.

The chosen research design also has several statistical advantages, among them large sample size, which allows a higher level of generalisation about trends and patterns at the population level. With data from multiple countries, one can also make more broadly applicable generalisations about the relationships between variables, as well as identifying outliers that do not match theoretical expectations. Large-scale studies allow for the minimisation of selection bias, and the ability to rule out competing explanations for the phenomenon of interest, by controlling for variables that might influence the outcome. This allows one to be more certain that the relationships observed reflect reality, rather than pertaining only to the particular sample under study.

Another benefit of using multi-country datasets for comparative analysis is that they enable researchers to distinguish empirically the extent to which the outcome of interest is associated with the characteristics of individuals, and the extent to which it results from country-specific features

(Bryan & Jenkins 2016). This is useful in the case of the gender difference in numeracy, because most studies to date have focused either on individual-level determinants or on country-level determinants. Only two studies I am aware of simultaneously quantify individual-level and country-level influences on the gender difference in numeracy (Dickerson et al. 2015; Gevrek et al. 2018).

Limitations of the chosen research design are discussed in the conclusion (Chapter 7). But because this study is interested in making population-level generalisations about the factors affecting gender differences in numeracy and their variation across countries, the large sample, comparative, variable-oriented approach is considered, on balance, the most appropriate research design. In the context of gender differences in numeracy, where there has been so much debate, international comparisons provide a straightforward way to demonstrate the relevance of social factors, given that there is no reason to believe that genetic or biological factors vary across countries (Penner 2008; Bedard & Cho 2010).

2.3 Data

PIAAC is a large-scale international study co-ordinated by the OECD. It measures the proficiency of adults in 'three information-processing skills essential for full participation in the knowledge-based economies and societies of the 21st century' (OECD 2013a: 1): literacy, numeracy, and problem-solving in technology-rich environments. The proficiency measures are use-oriented, placed in everyday contexts and measured on a continuum (rather than being characterised as 'illiterate' or 'innumerate', individuals are perceived as proficient to a greater or lesser degree). According to the OECD, the skills measured in PIAAC are necessary for participating in the labour market, education, training, and social and civic life. They are highly transferable and applicable to many work and social contexts, as well as being learnable and thus amenable to policy intervention (OECD 2013a: 18).

In addition to the skills assessments, the PIAAC study also consisted of a comprehensive background questionnaire covering the following areas:

- basic demographic characteristics and background of respondents
- educational attainment and participation
- labour force status and employment
- social outcomes
- literacy and numeracy practices and the use of skills.

More information on the background questionnaire design can be found in OECD (2011).

The OECD took responsibility for the conceptual framework, assessment, and questionnaire design, while research organisations in participating countries led on sampling and survey administration. The target population for PIAAC was the non-institutionalised population, aged 16–65 years, living in the country at the time of data collection, regardless of nationality, citizenship, or language status (OECD 2013c). Countries' sampling frames were required to cover 95 per cent of the target population. The OECD put stringent policies in place to limit non-response. In most countries, response rates were relatively high, between 50 and 75 per cent (OECD 2013b). The resulting data contain individual-level, item-level assessment data, overall assessment scores, and questionnaire data.

PIAAC is the only recent, large-scale study to directly measure the skills of representative samples of adults across a range of countries. Previous surveys such as the International Adult Literacy Study (IALS), conducted in the 1990s, and the Adult Literacy and Life Skills Survey (ALL), conducted in 2003 and 2006, also contain data on adult skills in different countries. However, these studies are now relatively dated, and focused mainly on literacy. As well as being more up to date and containing better numeracy measures, PIAAC improves significantly on IALS and ALL methodologies for measuring skills. The Survey of Health, Retirement and Ageing in Europe (SHARE), contains information on adults' cognitive skills, but skills are not the main focus, and the study only sampled adults over the age of 50. The British cohort studies data (the 1958 National Child Development Study and the 1970 British Cohort Study) contain high quality measures of basic skills but are limited in their focus on adults in born in Britain in 1958 and 1970. PIAAC was therefore the obvious choice of data source for an international study of gender differences in adult numeracy.

Size and scope of analysis

This thesis uses data from OECD countries that took part in the first round of data collection for the PIAAC study in 2011 and 2012. The 23 countries that took part in the first round were: Austria, Belgium (Flanders), Canada, Cyprus, Czech Republic, Denmark, UK (England and Northern Ireland), Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea (Republic of), Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, and the United States. Data from the Russian Federation were not made available due to procedural problems. Data from Australia was not made available via public use files. This left a country sample of 21 countries available for analysis. Data from Austria is used in some of the descriptive analysis in Chapter 3, but not in subsequent analysis due to non-availability on key variables. Other countries were excluded from chapters 5 and 6. Table 2.1 summarizes which countries are used in the empirical chapters, with reasons given where countries are excluded.

Table 2.1 Country sample by empirical chapter

Chapter	Countries included	Excluded countries + reasons
3	21: Austria, Belgium (Flanders), Canada, Cyprus, Czech Republic, Denmark, UK (England and Northern Ireland), Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea (Republic of), Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, and the United States.	Austria excluded from some analysis due to non-availability of key variables: explained where relevant.
4	20: Belgium (Flanders), Canada, Czech Republic, Denmark, UK (England and Northern Ireland), Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea (Republic of), Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden, and the United States.	Austria excluded due to non-availability of comparable variables on educational attainment.
5	17: Belgium (Flanders), Czech Republic, Denmark, UK (England and Northern Ireland), France, Germany, Ireland, Italy, Japan, Korea (Republic of), Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden, and the United States.	Canada, Estonia, and Finland excluded due to non-availability of detailed occupational codes.
6	16: Belgium (Flanders), Czech Republic, Denmark, UK (England and Northern Ireland), France, Germany, Ireland, Japan, Korea (Republic of), Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden, and the United States.	Canada, Estonia, and Finland excluded due to non-availability of detailed occupational codes. Italy excluded due to non-availability of data on gender division of household labour for required period.

The data are cross-sectional, collected in the stated countries in 2011–2012. Clearly, neither the countries nor the time-period are randomly selected, which is a standard requirement for statistical inference. Therefore, the conclusions cannot be used to make predictions about what would take place in other countries and in other time-periods.

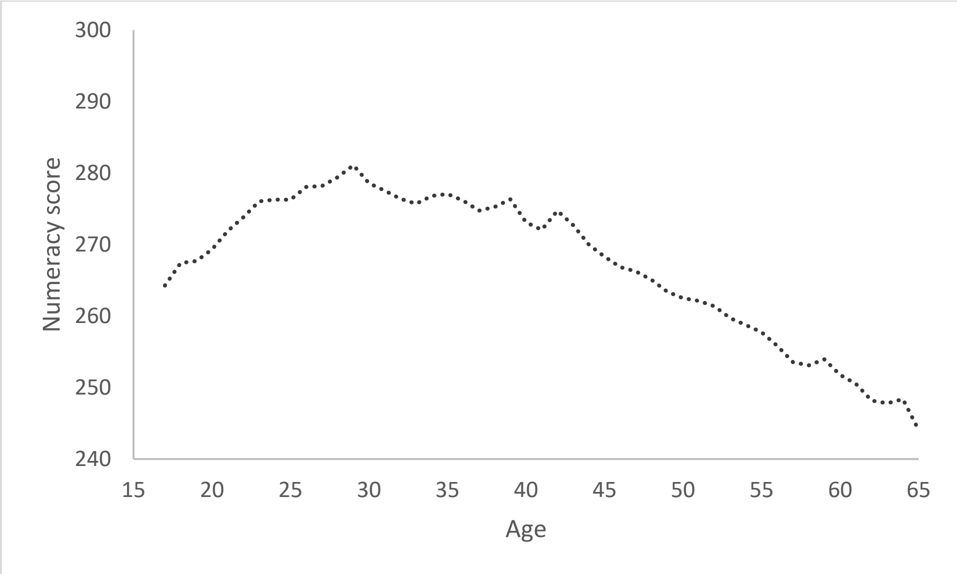
The degree to which countries are comparable is a central issue in cross-national comparative research (Hantrais 2008). A comparative study of this kind ideally contains countries that are relatively similar in certain essential features such as their stage of development and political orientation, yet different in respect of the variables of interest to the study. This is known as the Most Similar Systems design (Przeworski & Teune 1970). As members of the OECD, the PIAAC countries fulfil the criteria of relative similarity since there are conditions of membership in the organisation, such as a certain level of GDP, and the member countries share common goals, including promoting sustainable economic growth and innovation (OECD 2011a). OECD countries can therefore be thought of as a stratified sample, with the grouping based on the stage of economic development (Hantrais 2008; Hantrais & Mangen 2013). This similarity is important because it allows comparison of like with like. For example, all the countries have relatively well-developed education systems. This means that when we compare indicators such as educational attainment, we know that the levels refer to roughly the same standard. This would not be the case if we were comparing a country with high educational enrolment, to a country where most people completed only primary education. However, the countries in this study, while they are similar in many respects, also exhibit cultural, social, institutional, economic, and political diversity. Most importantly for this study, these countries vary in the size of the gender difference in numeracy, as well as on key indicators of gender inequality and segregation in education and the labour market.

In cross-national comparative research, countries are often grouped according to typologies, such as those developed by Pfau-Effinger (1998), Esping-Andersen (1999) or Blossfeld et al. (2015). These typologies can often aid with interpretation of country differences. However, since the determinants of the gender difference in adult numeracy are relatively unclear in the existing literature, countries are studied in their own right rather than applying a pre-existing typology. In Chapter 6, an initial grouping is presented based on the selected indicators of gender relations, but no attempt is made to fit the data into an established country typology. Throughout the analysis, I stress that the conclusions generated are strongly dependent on the selection of countries.

Age groups

The PIAAC study covers a large age range (ages 16–65). There are substantial differences in skills proficiency across age groups. Numeracy skills rise from adolescence to early adulthood, peak in the late 20s and early 30s, and then steadily decline with age (see Figure 2.1). However, this pattern varies by country, according to the timing of educational expansion, education quality, and demographic factors (Paccagnella 2016). This suggests the likelihood of country-specific cohort effects on skills proficiency. However, the decline in skills proficiency in adults over 30 also observed in synthetic cohort and longitudinal studies (Paccagnella 2016) suggests that there are also other age-related factors and processes involved in maintaining skills that are not captured solely by cohort effects. There may also be period effects associated with participants' age and situation at the time of testing.

Figure 2.1 The age profile of adult numeracy



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Results pooled across 20 countries.

Studies reach different conclusions regarding whether the decline observed in cognitive skills over the life course reflects age, period, or cohort effects (e.g. Reder 2009; Green and Riddell 2013). For example, some studies suggest that this is mainly an effect of biological ageing, while others suggest that it is mainly due to older adults' lower levels and poorer quality of educational exposure. However, gender-age interactions (the variation in the gender difference across age groups – displayed in Chapter 1, Figure 1.1) have barely been discussed, so is even less clear what type of effect these might illustrate. One the one hand, larger gender differences in older age groups could reflect differential cognitive ageing. However, there is little evidence for this from longitudinal and meta-analytic studies, which show that overall cognitive functioning declines at similar rates for men and women (Meinz & Salthouse 1998; Aartsen et al. 2003). This suggests that variation in the gender difference in adult numeracy across age groups may reflect cohort effects, resulting from older women's more disadvantaged position in society across their lifetime. For example, older women's skills in numeracy could have been subject to greater age-related decline than men's, as a result of lower exposure to the types of activities and exposures that enhance numeracy, such as education and labour market exposure. Age group differences are therefore sometimes referred to in this thesis as 'cohort' or 'generational' effects. However, despite this terminology, it should be noted that, as a cross-sectional study, PIAAC is unable to definitively distinguish empirically between age, period, and cohort effects (Hobcraft et al. 1985). This is discussed further in Chapters 3 and 4.

In certain chapters, the interest is in the whole adult population (taking account of age). In others, the analysis focuses explicitly on comparing different age groups. For example, Chapter 3 quantifies the gender difference in numeracy among different age groups, to generate an age-related profile of gender differences in numeracy and to compare this across countries. In Chapter 4, two generations of adults are compared (25-34-year-olds and 55-64-year-olds). In Chapter 5, however, the aim is to maximise the sample size available in each country, so the analytic sample includes all (employed) individuals aged 16-65, accounting for age in all analyses.

Supplementary data

The comparative analysis is enhanced using supplementary data. These data are from several sources, detailed in Table 2.2.

Table 2.2 Supplementary data sources

Data source	Description	Year
Barro and Lee education data	The Barro-Lee education dataset provides data on educational attainment for 146 countries in five-year intervals from 1950 to 2010. It provides information on qualifications as well as average years of education. The data on average years of education is used to create indicators of gender differences in years of education for Chapter 6.	2010
OECD Employment and Labour Market Statistics	OECD Employment and Labour Market Statistics are aggregated national statistics usually based on Labour Force Surveys. They contain data on employment and unemployment rates by age and gender; working time, and wages. The series Decile ratio of gross earnings incudes the gender wage gap defined as defined as the difference between median wages of men and women relative to the median wages of men.	2012
ILO Key Indicators of the Labour Market	The International Labour Organization (ILO) collects information from international data repositories, regional and national statistics to compile the Key Indicators of the Labour Market (KILM). Indicators for each country relate to employment (occupation, status, sector, hours, etc.), labour under-utilisation and the characteristics of job seekers, education, wages, labour productivity, and working poverty. Female labour force participation (as a percentage of the female population), a modelled estimate from this dataset, is used in Chapter 6.	2012
World Bank Gender Statistics	The World Bank Gender collates statistics on different aspects of gender in social and economic life around the world. Information from the Inter-Parliamentary Union on women's representation in parliament is used in Chapter 6.	2012
International Social Survey Programme: gender roles module	The Family and Changing Gender Roles module was incorporated in the International Social Survey Programme in 1988, 1994, 2002, and 2012. Topics covered include attitudes towards women's employment, marriage, children and financial support, household management, and partnership. The difference in average weekly housework done by men and women is calculated using this dataset and used as an indicator in Chapter 6.	2012
European Values Study	The European Values Study is a large-scale cross-national, longitudinal survey on the ideas, preferences, beliefs, attitudes, and values of people in Europe. Data on gender role attitudes from the 2008 survey are used in Chapter 6 (belief in male primacy; valuation of women's employment).	2008
World Values Survey	The World Values Survey is a large-scale international social survey programme studying changing values. Equivalent data to the above were obtained from the World Values Survey for the USA, Japan, and Korea from Wave 6.	2011-2014

2.4 Measurement

This section describes how the key concepts of this study are measured. In international comparative research, clarity in the description and measurement of concepts is of utmost importance, and researchers should strive for the maximum degree of equivalence across country contexts (Hantrais

2008; Davidov et al. 2014). Yet comparative studies, particularly those using large-scale international surveys, often rely on relatively crude approximations of social scientific concepts, which they trade off for large sample sizes and country coverage (Landman 2003). This section, then, pays particular attention to the extent to which measures can be compared across countries, and the efforts made to this end by both the designers of the PIAAC study and my own analysis.

2.4.1 Numeracy

The first aim of the thesis is to quantify and describe gender differences in adult numeracy across countries, both on average and at high and low skill levels. The definition and measurement of numeracy is therefore central to the analysis. Here, both its technical aspects and relationship to measures used in previous studies are described in some detail, building on the conceptual discussion in Chapter 1.

The PIAAC survey aims to measure 'numerate behaviour': solving problems in real-life contexts by responding to mathematical content that is presented in various different ways. This is a broad definition, referring to a wide range of skills covering four areas of mathematical content, information, and ideas: quantity and number; dimension and shape; pattern, relationships, and change; and data and chance (OECD 2013c). Assessment items are also characterised according to the use of numeracy they employ as well as the context in which the item is situated. Table 2.3 lists the facets of numeracy by which each assessment item is characterised.

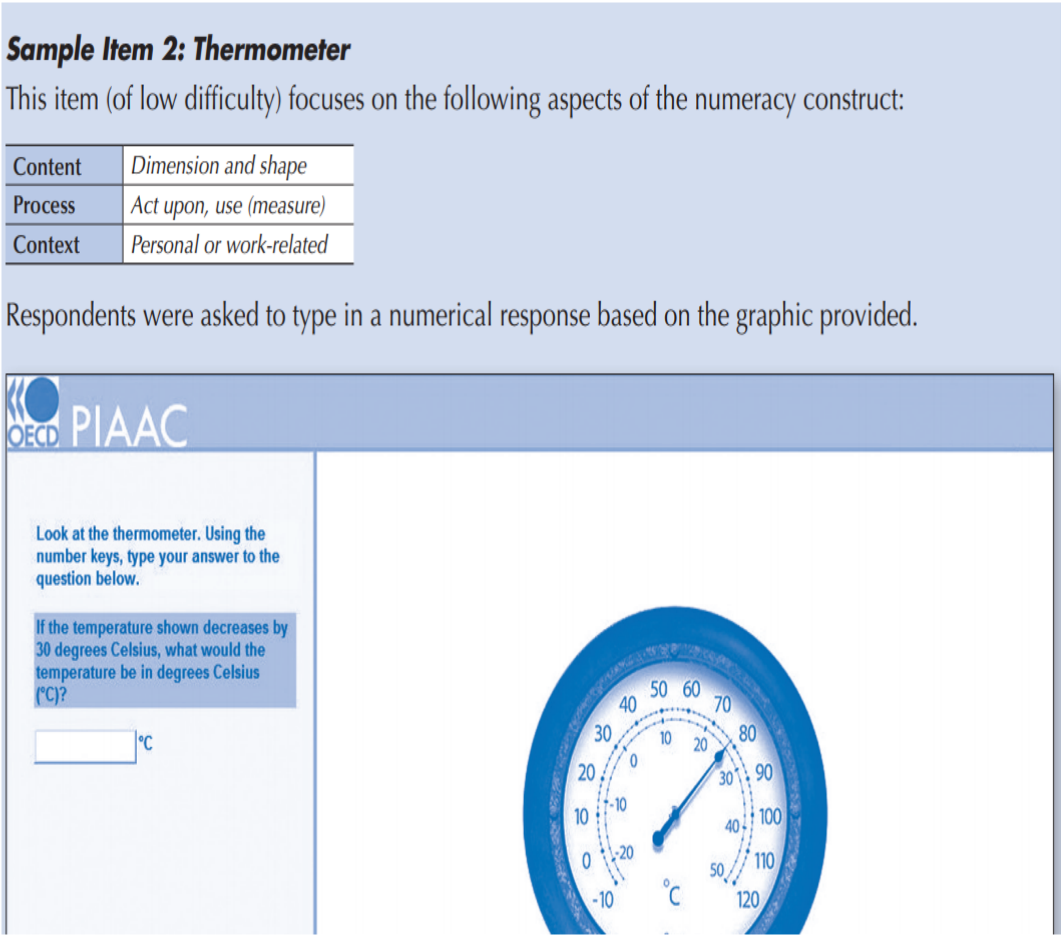
Table 2.3 Characterisation of numeracy assessment items

Content: what type of numeracy is covered?	Response: what do respondents need to do?	Context
Quantity & number	Identify, locate, or access	Everyday life
Dimension & shape	Act upon or use	Work-related
Pattern, relationships, change	Interpret, evaluate/analyse, communicate	Societal or community
Data & chance		

Source: OECD (2013b)

Below is an example item from the PIAAC numeracy assessment. This low difficulty item assesses dimension and shape, in an everyday or work context, and relies upon respondents to ‘act upon and use’ information (by measuring).

Figure 2.2 Example numeracy item from PIAAC


Sample Item 2: Thermometer

This item (of low difficulty) focuses on the following aspects of the numeracy construct:

Content	*Dimension and shape*
Process	*Act upon, use (measure)*
Context	*Personal or work-related*

Respondents were asked to type in a numerical response based on the graphic provided.

Source: PIAAC Reader's Companion, page 29 (OECD 2013b).

For more information on the background to the numeracy assessment, readers can refer to the PIAAC Numeracy Conceptual Framework (PIAAC Numeracy Expert Group 2009) and the PIAAC Reader's Companion (OECD 2013b).

Comparability with previous studies

As noted in Chapter 1, studies of gender differences in numeracy and related skills come to varied conclusions about the magnitude and significance of differences. This is partly because the studies are conducted using different samples, countries, and cohorts. The difference across studies also relates to how numeracy skills are measured. The majority of studies concerned with gender differences in numeracy or mathematical skills use tests of *visuo-spatial abilities* and *quantitative abilities*. The term *visuo-spatial abilities* refers to the processing of visual and spatial information: retrieval of images from long-term memory; generation, maintenance, transformation, and scanning of images; and the interplay among verbal, spatial, and pictorial mental representations (Halpern et al. 2007). Quantitative abilities include rote multiplication, word problems, and other more advanced mathematical tasks like calculus, topology, and geometry.

In contrast, PIAAC aims to measure a broader spectrum of numeracy skills, which cannot be easily split along a 'quantitative'/'visuo-spatial' divide. The PIAAC numeracy measure is somewhat comparable with previous international studies of adult skills, such as the ALL and IALS studies (PIAAC Numeracy Expert Group 2009). However, the PIAAC numeracy measure is significantly more detailed than these previous studies. IALS contained three literacy scales: Prose Literacy, Document Literacy, and Quantitative Literacy. Both the Document Literacy and Quantitative Literacy items covered some aspects of numeracy. However, the Quantitative Literacy tasks only required participants to complete basic arithmetic problems, which comprise only a subset of possible everyday numeracy tasks (PIAAC Numeracy Expert Group 2009).

The PIAAC numeracy measure is most comparable to the mathematical literacy measure devised for the OECD's international study of the skills of 15-year-olds' skills, PISA. PISA (OECD 2006: 12) defines mathematical literacy as:

> … an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.

Both PISA and PIAAC have a focus on real-world problems and items are set in similar contexts relating to personal, educational/occupational, public, and scientific life. However, although items are set in real life, PISA relates to school-based populations, so there is an underlying assumption that individuals will exhibit skills acquired in a school context. In contrast, adults can bring more personal experiences and prior knowledge to their numeracy performance. Therefore, PIAAC and PISA are should be viewed as related, rather than identical.

Numeracy scores

Numeracy scores provided in the PIAAC data range from zero to 500 and are standardised to be internationally comparable so that the same score indicates the same level of numeracy across countries. To facilitate the interpretation of the resulting scale scores, each scale was divided into skill proficiency levels with 50-point intervals.

PIAAC used a sampling method commonly used in international studies of educational attainment, whereby each respondent completes a subset of test items from the total pool of potential test items. This method is used because it maximises the amount of item-level information obtained without over-burdening individual participants. Another reason for choosing it is that these studies are mainly used for the analysis of skills at the population and sub-population level, so individual participants' scores are not necessary.

Because different groups of respondents answer different sets of test items, it is not appropriate to use a statistic such as the number or proportion of correct responses, since this may be related to the difficulty of the particular set of items or to the characteristics of respondents. For these reasons, Item Response Theory (IRT) scaling methods are used. IRT is a genre of latent variable model commonly used in psychological and educational assessment (Hambleton & Swaminathan 1985). The basic procedure is to create a latent regression item response model (which incorporates item difficulty and a guessing parameter). This model incorporates test responses from the subsample of items completed by each individual, as well as covariates from the background questionnaire, to predict ten possible scores for each individual. For more details on the item response scaling procedure used in PIAAC, see Von Davier et al. (2006) and OECD (2013b, Chapter 17). For more information on the use of plausible values in deriving estimates of group proficiency, see Mislevy (1991).

The use of item response scaling methods in PIAAC means that individual scores are estimated, rather than directly observed. Each participant in the dataset has ten possible scores or 'plausible values'. These plausible values should never be used to generate individual-level inferences and should only be used at the population or sub-population level. Estimation using only one of these values would be biased and even using the average of each set of plausible values would produce incorrect results. This means that the routine procedures of statistical software are not appropriate for analysing PIAAC data and specially written components must be used.

Throughout the analysis, results are combined across these 'plausible values'. For regression analysis, I use the 'repest' package in Stata, developed by Avvisati and Keslair (2016). This package was developed to deal simultaneously with complex sampling weights and plausible values, which it treats as a type of multiply imputed quantity. The package calculates the average estimator across multiply imputed values as well as calculating the correct degree of error that results from the values being estimated, and hence the correct standard errors. For most descriptive analyses, I use the 'piaactools' package (Pokropek & Jakubowski 2013), which operates similarly but presents descriptive results in a more user-friendly format.

Measuring the gender difference

When researchers say 'males are better at x' or 'females are better at y', it is important to understand the magnitude of the difference (Halpern et al. 2007). This is particularly important in an international comparative context because the range and variation of scores within countries affects whether a gender difference in mean scores is interpreted as ‘small’ or ‘large’. The most widely used standardised measure of differences in means is the effect size, Cohen’s D (Cohen 1988):

(1) $$d = \frac{\overline{X}_m - \overline{X}_f}{\sqrt{\frac{SD_m^2 + SD_f^2}{2}}}$$

Where $\overline{X}_f$ is the mean for females and $\overline{X}_m$ is the mean for males. SD_f and SD_m are the respective standard deviations for each group distribution. The measure therefore indicates how far the means of the two groups are from one another in standard deviation units. Where the female average is subtracted from the male average, the statistic represents the male advantage (and vice versa).

Compared to raw mean differences, effect sizes are a preferable method to assess differences in sample means because they are not influenced by the distribution of scores in the sample (which may be the case if one uses only a point score difference). The approach in this study is to use effect sizes when descriptive results are presented, and to use the gender coefficient from the regression model predicting average numeracy scores in all further inferential analyses. Equation 2 below is used to calculate the ‘raw’ gender difference in mean numeracy score in this regression framework with no covariates and is equivalent to subtracting the female mean score from the male mean score. Equation 3 represents the situation where we add control variables X_k . The gender coefficient β_1 then represents the male advantage in numeracy when controlling for X_k .

(2) $$y_i = \beta_0 + \beta_1\, male_i + \varepsilon_i$$

(3) $$y_i = \beta_0 + \beta_1\, male_i + \beta_k\, X_i + \varepsilon_i$$

Differences across the distribution

A number of studies on gender and mathematical skills have shown that skill differences tend to emerge at the extremes of the distribution, among low and high achievers, as well as on average

(Hedges & Nowell 1995; Hyde 2005; Strand et al. 2006; Halpern et al. 2007; Lohman & Lakin 2009). This literature is discussed in greater detail in Chapter 3.

In this study, the assessment of 'high' and 'low' numeracy levels is based mainly on PIAAC international benchmarks. The PIAAC numeracy score has a mean of approximately 266 and standard deviation of approximately 54 across participating OECD countries (OECD 2013a: Table A2.6b). To be classified as 'high skilled' in numeracy, an individual must score above the 75th percentile of numeracy scores, achieving 304 points or more. Tasks at this level include working with spatial representations, recognising mathematical relationships and patterns, and interpreting data from statistics and graphs. Individuals must be able to access tasks located in everyday, non-mathematical contexts. At the highest level within this 'high skilled' category, participants can engage in complex mathematical reasoning and communicate well-reasoned explanations for their answers (OECD 2013a). Scoring 238 points or below, 'low skilled' respondents can carry out simple procedures in common, concrete contexts. Tasks include counting, sorting, basic arithmetic, and recognising common shapes. Little to no application to non-mathematical contexts is expected.

The majority of studies that examine gender differences in the extremes of the numeracy or mathematics skill distribution use differences in variance or the ratio of male to females in certain portions of the distribution (e.g. Hedges & Nowell 1995; Strand et al. 2006; Machin & Pekkarinen 2008; Lakin 2013). Gender differences at distribution extremes have also been explored using quantile regression, an adaptation of the linear regression framework which models the median or other quantiles of the response variable as a function of explanatory variables (Koenker & Bassett 1978). For example, this technique is used in Penner (2008) to model gender differences at percentiles of the TIMSS mathematics score distribution. The present study follows the approach set out by Xie and Shauman (2003) for examining gender differences at distribution extremes, using logistic regression. While quantile regression was also considered, logistic regression was deemed a clearer approach for quantifying gender differences at either end of the distribution. Grouping PIAAC respondents into 'high skill' and 'low skill' categories and using these groupings for subsequent regression analysis has also been used successfully in other research (e.g. Jerrim 2015). Moreover, the complex estimation procedures and relatively small country sample sizes mean that quantile regression models would not converge.

To assess differences at high and low numeracy levels, logistic regression analyses were run for each country with gender (male) as the only predictor. The resulting odds ratios represent the odds for men (compared to women) of scoring above 304, or below 238.

The logistic regression equation for the gender difference at high skill levels is:

(4) $$ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1\, male_i + \varepsilon_i$$

Where β_0 represents the log odds for women of scoring above 304 points, $\beta_0 + \beta_1$ represents the log odds of scoring above 304 points for men, and β_1 represents the difference in the log odds between men and women.

When we exponentiate these log odds we can calculate an odds ratio, Y:

(5) $$Y = \frac{\exp(\beta_0 + \beta_1)}{\beta_0}$$

This odds ratio compares men and women's odds of scoring above 304. Equivalent calculations can be made to estimate the log odds and odds ratio of men and women scoring below 238 points.

Advantages and disadvantages of the PIAAC numeracy measure

Measures of adult skills are often self-reported or rely on perceptions of what skills are needed for a particular job (for example, in Employer Skill Surveys). Alternatively, education level and occupation can be used as proxies for skills (Green 2013). While measurements of educational attainment and adolescents' scores on assessments are relatively common and regularly collected, for example in PISA and TIMSS, internationally-standardised measurements of adults' skills are less common. From this perspective, the PIAAC adult numeracy measure is a huge improvement on what was previously available, because it directly assesses numeracy skills rather than inferring skill levels from other proxy variables or relying on assessments of adolescents' skills to infer population skill levels.

However, the PIAAC numeracy measure also has some disadvantages. Due to the sampling method and consequent plausible values methodology for estimating scores, there is more uncertainty than with other types of assessment. The scores are more cumbersome to work with analytically and require the use of supplementary software components. Also, the numeracy score scale is not immediately intelligible in the way that a total score or proportion might be, and thus requires careful interpretation and presentation. Due to these idiosyncrasies, the PIAAC numeracy measure is not directly comparable to previous studies. It cannot be linked directly to any previous study (although some limited trend comparisons are possible with IALS and some researchers have explored synthetic cohort methodologies to compare scores with PISA (Green & Pensiero 2016)). Comparisons with previous studies of gender differences in numeracy and related skills should therefore be made, and viewed, with caution.

Beyond these more technical concerns, the content of what is measured in PIAAC has been the subject of critique. Because all of the PIAAC skills assessments are situated in 'everyday' contexts, there is potential for those contexts to be culturally specific. Although tests are carried out by the OECD to ensure that test items do not function significantly differently in different countries (OECD 2013b), a certain cultural bias can never be completely eliminated. Critical education theorists argue that PIAAC conceptions of numeracy are too narrow (Tsatsaroni & Evans 2014; Kanes et al. 2014). Moreover, experts in the assessment of numeracy suggest that it is difficult to measure numeracy across such a broad age range using the same assessment, because individuals of different ages use different problem-solving strategies for similar problems. Therefore, PIAAC might be measuring differences in the way individuals respond to problems, as opposed to genuine differences in underlying skills (Levine et al. 2016).

2.4.2 Other individual-level measures

As described in Chapter 1, the thesis goes beyond documenting gender differences, by examining whether the characteristics and experiences of individual men and women are associated with their relative numeracy skill levels. This is done by examining the extent to which variables including educational attainment, labour market participation, and occupation and industry of work explain gender differences in numeracy skills in multi-variable regression models. These variables are all obtained from the PIAAC background questionnaire.

This section outlines the individual-level variables used in the analysis, highlighting some of their strengths and weaknesses, as well as describing the questionnaire items they correspond to and how they were coded for use in the analyses. It also describes the control variables used in the individual-level analysis. A summary of all the individual-level variables can be found in Table 2.7. Justification for the variables selected is found in Chapter 1; this section focuses mainly on measurement.

Education (Chapter 5)

Education level

One of the key research questions is whether gender differences in adult numeracy can be explained by differences in the education levels of men and women. Education level is also important in subsequent analysis as a control variable, so the other variables' associations with adult numeracy can be ascertained independently of this key influence on skills.

In the PIAAC background questionnaire, self-reported **level of completed education** is coded according to the International Standard Classification of Education (ISCED). Intended as an improvement on measures such as years of education and designed to improve efforts at harmonising education measures in international datasets, ISCED is an internationally agreed classification designed for the cross-national coding, analysis, and reporting of data related to educational programmes and qualifications (UNESCO 2012a). PIAAC uses the 1997 version of the classification[9]. Table 2.4 shows the categories of ISCED 1997.

Table 2.4 Levels of the ISCED 1997 and corresponding education level

ISCED level	Level of education
0	Pre-primary education
1	Primary education
2	Lower secondary education
3	Upper secondary education
4	Post-secondary non-tertiary education
5	First stage of tertiary education (Bachelor's degree)
6	Second stage of tertiary education (Master's and PhD)

Source: UNESCO 2012a.

Using ISCED to measure educational qualifications is not without limitations (Massing & Schneider 2017). For example, ISCED does not differentiate between vocational and academic programmes, nor is it well placed to capture the complexity of a given educational programme. Also, there are some irregularities in how the codes are applied. For example, the boundary between ISCED levels 2 and 3 is disputed in Britain and in countries where schooling is based on the British education system (Steedman et al. 2001). A recent study found considerable differences across countries in the average literacy skills associated with the same ISCED level, which is problematic when these levels are

[9] The classification was updated in 2011 but not in time for the PIAAC study.

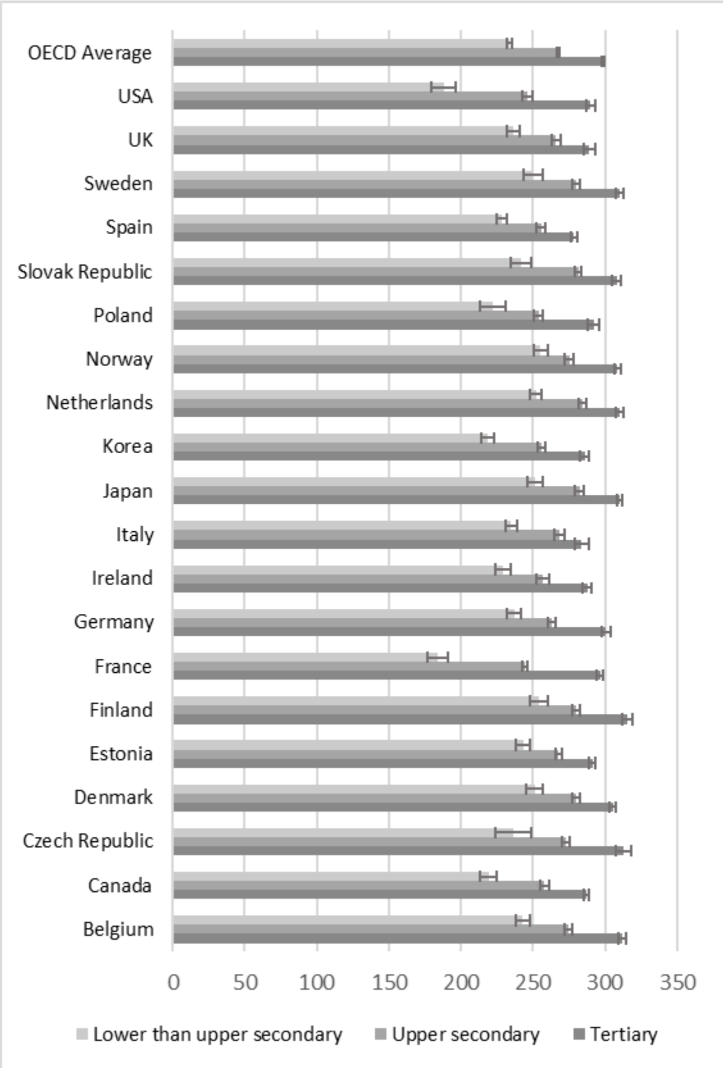
supposedly equivalent (Massing & Schneider 2017). A further limitation of the way the ISCED is used in PIAAC is that education levels are inferred from individuals' self-reported years of education. This approach will give rise to measurement error if, for example, an individual took longer than average to complete a course of study.

In this thesis, education level is operationalised by creating three dummy variables to represent tertiary, upper secondary, and post-secondary, non-tertiary[10] qualifications. These are compared to all levels below, along with foreign qualifications, which have been combined. Figure 2.3 shows, for the whole adult sample in each country, the average numeracy score for three education categories: below upper secondary, upper secondary, and tertiary. Although this chart does not control for other key influences on adult numeracy, it illustrates the strong relationship between educational qualifications and adult numeracy in all countries.

An alternative approach to measuring individuals' education would be to use self-reported **years of education**. However, it is also the case that, due to variations in the quality of education, a year of education produces different skills gains across countries and cohorts (Hanushek & Zhang 2009), so neither method is without limitations. In the analysis in Chapter 4, as a robustness check, the analysis is supplemented using years of education as an alternative measure of educational attainment.

[10] 'Post-secondary, non-tertiary' is used where applicable – not all countries have individuals in this category.

Figure 2.3 Average numeracy by education level, adults aged 16–65, PIAAC 2012



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

Field of study

Field of study is central to the analysis in Chapter 4, which asks to what extent gender differences in field of study choice can explain gender differences in adult numeracy.

In the PIAAC background questionnaire, self-reported field of study is applicable mainly to upper secondary and tertiary education. Respondents were asked: "*What was the area of study, emphasis or major for your highest level of qualification? If there was more than one, please choose the one you* *consider most important*". This was an open question, which was coded into the nine categories of the ISCED 1997 Broad Fields of Education and Training classification. Further guidance on how to code the open responses into the nine categories was provided by CEDEFOP (1999).

Table 2.5 lists the broad field of study categories with examples of the educational programmes included in each. Table 2.5 provides only a few well-known examples of programmes. For more details of what is included in each category, see CEDEFOP (1999).

Table 2.5 ISCED 1997 Broad Fields of Education and Training and example programmes

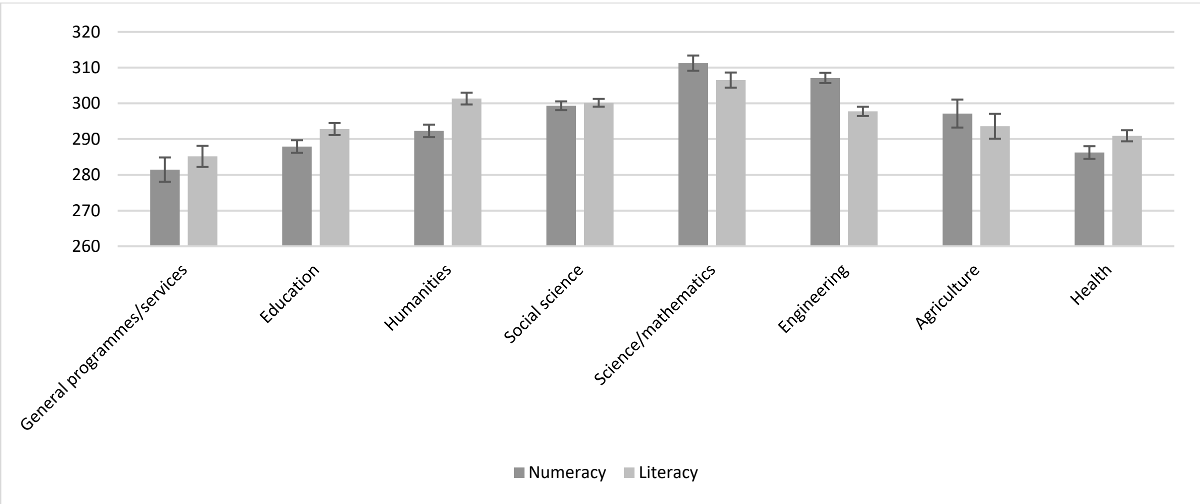
Field	Example programmes
General programmes	Literacy and numeracy
	Basic programmes
	Personal development
Education	Teacher training
	Education science
Arts and humanities	Fine arts
	Performing arts
	Religion and theology
	Mother tongue
	Foreign languages
	History
	Philosophy
Social sciences, business and law	Social and behavioural science
	Journalism
	Sales
	Finance
	Management
	Law
Science, mathematics and computing	Life science
	Physical science
	Mathematics and statistics
	Computer science
Engineering, manufacturing and construction	Mechanics and metal work
	Electricity and energy
	Chemical process
	Vehicles
	Food/textile/material production
	Mining
	Architecture
	Civil engineering
Agriculture	Crop and livestock production
	Forestry
	Fishery
	Veterinary
Health and welfare	Medicine
	Nursing
	Dentistry
	Childcare and youth services
	Social work
Services	Catering
	Domestic services
	Transport
	Security

Source: CEDEFOP (1999)

As Table 2.5 shows, the field of study categories are very broad, incorporating diverse programmes. ‘Health and welfare’ is probably the most problematic category because it incorporates medicine, nursing, and social work, which are very different fields, leading to divergent labour market opportunities. However, as with much cross-national research, this broad measure is the best available.

To get a better sense of how these broad fields of study are related to adult skills, Figure 2.4 shows average PIAAC literacy and numeracy scores by ISCED Broad Fields of Education and Training for tertiary graduates aged 25–65 (the pooled average across all countries). Graduates who have studied science, mathematics, and engineering have the highest numeracy skills on average. Literacy skills are also highest among science graduates. Both types of skills are lowest among graduates from general programmes and services, which are combined for this analysis. This figure shows that, despite being broad, ISCED Broad Fields of Education and Training do meaningfully distinguish between individuals and relate to adult skills in the manner that may be expected.

Figure 2.4 PIAAC numeracy and literacy by ISCED 1997 Broad Fields of Education and Training



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Results pooled across 20 countries.

Work-related variables (Chapter 5)

Both theory and empirical evidence point to the central role of work to the development, maintenance or weakening of skills over the life course. Work-related variables are also central to this analysis because of their hypothesised relationship to differences in adult numeracy between men and women.

As part of the background questionnaire, individuals were asked to report their current activity at the time of the survey and seven days prior to the survey. This contributed to the derived variable 'subjective work status', which has the following categories:

- Employed or self-employed
- Retired
- Unemployed
- Student (including work programmes)
- Doing unpaid household work
- Other
- Missing (valid skip, don't know, not stated or inferred).

Occupation

The International Standard Classification of Occupations (ISCO) is a tool developed by the International Labour Organization for organising jobs into clearly defined groups according to the tasks and duties undertaken. In the PIAAC background questionnaire, employed individuals reported their current job (referring to the past seven days) in response to two questions:

- *"What is your job title?"* (D_Q01a)
- *"What are your most important responsibilities? Please give a full description"* (D_Q01b)

Respondents were asked to be as specific as possible when answering the first question, avoiding terms like 'manager'. In the second question, respondents were asked to refer to specific activities such as 'stacking shelves' or 'looking after sick animals'. The responses to these two questions were coded by each national research organisation into the four-digit version of ISCO 2008 (OECD 2011b). Examples of the ISCO codes and occupation titles can be found in Appendix A5.3.

Industry

Individuals' jobs were also coded into categories of the International Standard Industrial Classification of all Economic Activities (ISIC). For the analysis in Chapter 5, these categories are aggregated into the following classification, derived by Singelmann (1978), as in Table 2.6.

Table 2.6 Singelmann (1978) classification scheme applied to ISIC Rev 4 categories

Singelmann category	ISIC categories
Extractive/transformative	A Agriculture, forestry and fishing B Mining and quarrying
Transformative	C Manufacturing D/E Utilities F Construction
Distributor services	G Wholesale and retail trade H Transportation and storage J Information and communication
Private services	K Financial and insurance activities L Real estate activities M Professional, scientific and technical activities N Administrative and support service activities
Social services	O Public administration and defence; compulsory social security P Education Q Human health and social work activities U Activities of extraterritorial organizations and bodies
Personal services	I Accommodation and food service activities R Arts, entertainment and recreation T Activities of households as employers S Other service activities

Source: Singelmann (1978).

In the analysis, 'extractive', 'transformative' and 'distributor services' serve as the base category and the other categories are entered as separate dummy variables.

Occupational status

I measure occupational status using the International Socio-economic Index of Occupational Status (ISEI) (Ganzeboom & Treiman 1996; Ganzeboom 2010). I allocated scores based on the ISCO-08 codes given in the PIAAC data, using an equivalency table provided by Ganzeboom. The ISEI is based on occupations' average profiles in terms of income and educational qualifications held by their incumbents (with some adjustment for age profiles). It is designed to be applicable for cross-country analysis in that the same scores are applicable to the same occupations across different societies.

Chapter 5 also develops a new approach to classifying occupations based on their average numeracy skills use, termed 'numeracy-intensiveness'. This approach uses items on skills use from the Job Requirements Approach (JRA) module of the PIAAC background questionnaire, aggregated to the occupation level. The approach builds upon approaches to classifying occupations based on their task and skills use profiles, for example Marcolin et al. (2016) and Green and Henseke (2016). The approach is described in more detail in Chapter 5.

Economic sector

Individuals also reported the economic sector in which their job was located, with the following categories:

- Public sector
- Private sector
- Non-profit sector

In the Chapter 5 analysis, a dummy variable for 'public sector' is compared to the reference category including 'private sector' and 'non-profit sector'.

Control variables

Throughout the analysis, to identify independent associations using the variables of interest, a series of control variables are used, which represent important influences on adult numeracy.

Parents' education

Parents' education is an important proxy indicator for aspects of socio-economic background that influence initial skill acquisition, including the provision of a stimulating home learning environment, access to better knowledge about the education system and educational decision-making (Buchmann 2002; OECD 2013a). Parents' education is strongly related to literacy and numeracy skills acquisition in early childhood (Melhuish et al. 2008; LeFevre et al. 2009), and this strong association remains when it comes to adult skills, even when controlling for an individual's own educational qualifications and labour market experiences (Bynner & Parsons 2009; OECD 2013a; Green et al. 2015).

Parents' education was reported by survey respondents as part of the background questionnaire. ISCED levels were then allocated for each parent, and combined into the 'pared' variable:

- Neither parent has attained upper secondary
- At least one parent has attained secondary and post-secondary, non-tertiary
- At least one parent has attained tertiary

For this study, 'pared' is recoded into a dummy variable, 'at least one parent tertiary' versus 'neither parent tertiary' (a combination of the first two categories). A possible weakness of this measure is that both parents' education levels are combined, whereas more fine-grained analyses of the influence of parental background on educational outcomes have shown that mothers' and fathers' education may exert a separate influence (Korupp et al. 2002).

Immigrant status

Another important characteristic to account for is an individual's migration background. Most OECD countries have experienced a steady increase in immigration over the past few decades, and migration background is known to have a strong influence on educational outcomes (Heath et al. 2008; Marks 2005). If an individual has received their education in another country (and another language) this may inhibit their performance on the PIAAC skills assessments. Second-generation immigrants may also be disadvantaged by their parents' lack of knowledge of the education system, as well as suffering from discrimination in the labour market which may affect their ability to maintain and further develop skills in adulthood. OECD (2013a) and Heisig and Solga (2015) found strong associations between migration background and adult literacy and numeracy, even after adjusting for parental education, own education level, and occupation.

The PIAAC dataset contains a variable called 'imgen', with the following five categories:

- 1st generation immigrants
- 2nd generation immigrants
- Non 1st or 2nd generation immigrants
- Non-immigrant and one foreign-born parent
- Not stated or inferred.

In the present analysis, a new variable is created which represents '1st or 2nd generation immigrant', compared to all other categories. A possible weakness of this measure is that it does not distinguish between language and immigration influences on skills.

Age

Age is accounted for in all analyses, as discussed earlier.

Table 2.7 provides a summary of all individual level variables.

Table 2.7 Summary of individual-level variables

Thematic area	Variable	Measurement (including reference categories where applicable)
Gender	Gender	Male (Ref: female)
Education	Level of completed education	• Upper secondary • Post-secondary, non-tertiary • Tertiary Ref: lower than upper secondary, foreign qualifications.
	Field of study	Numerate field (ref: all other fields)
Work	Work status	• Employed or self-employed • Retired • Not working and looking for work • Student (including work programmes)

	• Doing unpaid household work • Other • Missing (valid skip, don’t know, not stated or inferred).
Industry sector	• Private services • Social services • Personal services Ref: Extractive/transformative; distributor services.
Occupational status	ISEI score

	Economic sector	Public sector Ref: private sector, non-profit sector
	Occupation numeracy-intensiveness	A measure of numeracy skills use within occupations. See Chapter 5.
Immigrant status		1st or 2nd generation immigrant Ref: not 1st or 2nd generation immigrant.
		At least one parent tertiary

Parents' education level	Ref: both parents less than tertiary.
Age	16-25; 35-44; 45-54; 55-64. Ref: 25-34.

2.4.3 Country-level indicators

The thesis also examines links between characteristics of countries and the country-level gender difference in adult numeracy. The country-level indicators are all obtained from supplementary data sources, described in section 2.1 or calculated using the PIAAC data.

This section outlines the country-level variables that are central to analysis. A summary of all the country-level indicators used in the analysis can be found in Table 2.8. Table 2.8 includes variable names, sources, definitions, coding and measures of location and dispersion. Further justification of the choice of indicators and further details on their construction can be found in Chapter 6 and in the Appendix to Chapter 6.

Table 2.8 Summary of country-level indicators

Variable	Data source	Variable definition	Coding	Variable name	Mean	SD	Min	Max
Years of education, women-men	Barro and Lee dataset	Educational attainment for total, female and male population 15 years and over.	Years education women - years education men	Yearsed	0.33	0.34	-0.25	0.88
Gender wage gap	OECD	The gender wage gap is defined as the difference between male and female median wages divided by the male median wages.	NA	Wagegap	14.76	7.85	6.41	36.30
Labour force participation (% of female population)	ILO	Labour force participation rate, female (% of female population aged 15-64) (modelled ILO estimate).	NA	LFP	53.92	4.50	47.10	61.60
Representation of women in parliament	World Bank Gender Statistics (original source: Inter-Parliamentary Union (IPU))	The proportion of seats held in national parliaments, is the number of seats held by women in single or lower chambers of national parliaments, expressed as a percentage of all occupied seats.	NA	Parliament	27.47	11.04	7.90	44.70
Gender difference in housework hours	International Social Survey Programme 2012; gender roles module	R 16a (2002: 9a) On average, how many hours a week do you personally spend on household work, not including childcare and leisure time activities? (Questionnaire - https://dbk.gesis.org/DBKsearch/SDESC2.asp?no=5900&tab=3&db=E)	Mean hours women - mean hours men	Meanhours_housework_FM	6.58	3.53	2.80	14.30

Level of industry segregation	PIAAC 2012: Singelmann (1978) classification scheme applied to ISIC Rev 4 categories.	ISIC categories: A. Agriculture, forestry and fishing B. Mining and quarrying C. Manufacturing D. Electricity, gas, steam and air conditioning supply E. Water supply; sewerage, waste management and remediation activities F. Construction G. Wholesale and retail trade; repair of motor vehicles and motorcycles H. Transportation and storage I. Accommodation and food service activities J. Information and communication K. Financial and insurance activities L. Real estate activities M. Professional, scientific and technical activities N. Administrative and support service activities O. Public administration and defence; compulsory social security P. Education Q. Human health and social work activities R. Arts, entertainment and recreation S. Other service activities T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use U. Activities of extraterritorial organizations and bodies	Dissimilarity index across Singelmann categories: 1 Extractive 2 Transformative 3 distributor services 4 producer services 5 social services 6 personal services (For calculation of dissimilarity index see Chapter 5. Theoretical range 0-1).	Dissim_industry	0.31	0.04	0.23	0.38
New indicators of employment in occupations low/high in numeracy-intensiveness	Constructed in Chapter 5.	Female over-representation in low numeracy-intensiveness occupations	Female percentage – male percentage in lowest quartile of occupation numeracy-intensiveness.	Lownum_f	6.13	8.52	-14.8	17.62
		Female under-representation in high numeracy-intensiveness occupations	Male percentage – female percentage in highest quartile of occupation numeracy-intensiveness.	Highnum_m	8.05	7.64	-4.79	20.61

Gender culture (Importance of a job for women; primacy of men in the labour force)	European Social Survey 2012 European Values Survey 2008/9 World Values Survey (Japan and Korea)	'Having a job is the best way for a woman to be an independent person' (EVS/WVS).	Percentage who 'disagree' or 'strongly disagree'	Womanwork	18.43	8.67	5.60	36.20
		'When jobs are scarce, men have more right to a job' (EVS/WVS) (+)	Percentage who 'agree' or 'strongly agree'	Jobrights	16.28	10.09	2.30	32.20

2.5 Missing data

Missing data are a problem in all social science research, and there must be a strategy to deal with potential consequences for the analysis. Missing survey data may occur when there are no data at all for a respondent (unit non-response), or when some variables for a respondent are unknown, cannot be known, refused, or otherwise not useful (item non-response) (Little & Rubin 2015). This section outlines the approach taken in this study to dealing with various different types of missing data at both the individual and country levels.

Unit non-response

In the countries participating in PIAAC, response rates varied between 45% and 75%. All countries with response rates of less than 70% were required to undertake extensive analyses of the bias associated with non-response. The outcome of these analyses was that the bias associated with non-response is regarded as being minimal in most countries (OECD 2013a).

In most participating countries, however, a proportion of respondents were unable to undertake the assessment for literacy-related reasons, such as being unable to speak or read the test language(s), having difficulty reading or writing, or having a learning or mental disability. These respondents are known as Literacy Related Non-Response (LRNR) and their data records are still included in the public use data files. Researchers have taken various approaches to dealing with LRNRs to date. For example, Heisig and Solga (2015) impute scores for LRNRs because their analysis concerns individuals with low skill levels. The approach taken in this analysis is to exclude LRNRs completely. In most countries, LRNR represented less than 5% of the total sample. The numbers of individuals excluded on this basis are detailed in Table 2.9.

Table 2.9 Literacy-related non-response (LRNR) by country

Country	% LRNR
Belgium	5.15
Canada	0.87
Czech Republic	0.62
Denmark	0.38
Estonia	0.38
Finland	0.00
France	0.84
Germany	1.48
Ireland	0.47
Italy	0.65
Japan	1.24
Korea	0.27
Netherlands	2.26
Norway	2.25
Poland	0.00
Slovak Republic	0.27
Spain	0.76
Sweden	0.00
UK	1.41
USA	4.23

Source: Survey of Adult Skills (PIAAC) (2012), Table A2.1

Item non-response

There is no missing data on the dependent variable (adult numeracy score) and each case in the data has ten estimates of their numeracy score, as described in section 2.4. The PIAAC technical report (OECD 2013b) advises that no imputation was intended for any missing item responses except for the imputation of earnings from precise and/or broad categories and the multiple imputation of proficiency scale scores for the literacy, numeracy, and problem-solving domains. In some cases where missingness was relatively high, I used missing dummies in the analysis. This is explained where applicable in each chapter.

Country-level missing data

At the country level, data were not always available from the supplementary data sources for a given country and for the relevant years. A number of estimation strategies can be used to impute this type of missing data, including linear interpolation and multiple imputation (Nardo et al. 2008). However, due to the relatively low number of countries, and therefore the sparsity of data with which to compute such estimates, these approaches were not justified. Unfortunately, Italy was excluded from the country-level analysis based on its lack of data on some indicators for the relevant years (see Chapter 6 for more details).

2.6 Modelling strategy

The PIAAC data have a two-level structure, in that individuals are nested within countries. This would immediately suggest the use of a multilevel framework, in which the outcome variable is modelled as a function of both individual-level and country-level characteristics (observed and unobserved) (Goldstein 1987; Bryan & Jenkins 2016). Table 2.10 summarises the data structure and variables at each level.

Table 2.10 Data structure and variables

Level 1: 143,492 individuals
Dependent variable: adult numeracy score
Independent variables: gender, education level, field of study, work status, occupation, and industry of work
Control variables: age, age squared, immigrant status, parents' education
Level 2: 20 countries
Dependent variable: gender difference in adult numeracy, aggregated to the country level (Level 1 coefficients)
Independent variables: Configurations of gender relations; indicators of gender relations

In recent years, the multilevel regression methods commonly employed by comparative social science researchers have come under increased scrutiny, from both epistemological and methodological points of view (Kenworthy 2007; Shalev 2007a; Bryan & Jenkins 2016; Goldthorpe 2016; Heisig et al. 2017). As Shalev describes, in the multilevel regression methods commonly used in cross-national comparative research, individual country cases are subsumed beneath broader generalisations about the relationships between variables (Shalev 2007a, 2007b). Often, these generalisations are not appropriate or justified once one considers broader sets of countries. Also, this type of analysis is not usually able to disentangle complex causal relationships.

Beyond the concerns raised by Shalev, there is also some uncertainty about the statistical robustness of the multilevel regression methods used in many comparative studies. For example, Heisig et al. (2017) note that the common assumption that the effect of individual-level variables is the same across countries (the 'invariant coefficients assumption') is rarely realistic. This can make estimates of country-level contextual effects less precise. This is particularly concerning when researchers have fewer country cases to work with. Moreover, when there are relatively few countries in a multilevel dataset, there is less information with which to estimate country-level effects. Simulations conducted by Bryan and Jenkins (2016) suggest that a minimum of 25 countries is needed to reliably estimate country effects in a multilevel linear regression framework.

Due to the relatively small number of country cases available in the PIAAC data and the general limitations just outlined, this study uses a combination of descriptive and inferential multivariate methods, and to relies mainly on a 'two-step' approach to comparative analysis (Heisig et al. 2017). The descriptive part of the analysis involves a number of methods including tabulation, graphical display, and diagrammatic representation of results. Chapter 3 is primarily dedicated to this purpose. These visual and diagrammatic methods of presentation are intended to take advantage of the relatively small sample of countries to examine country-specific features in relation to the research questions. Throughout chapters 4 and 5, I present results on a country-by-country basis. This can reveal country groupings that may be relevant to interpretation as well as identifying anomalous cases and limitations in the theoretical model, which is particularly important when there are fewer countries to work with (Shalev 2007a, 2007b; Bryan & Jenkins 2016;).

Within the inferential part of the analysis, I use a two-step method. The method separates the analysis of level 1 and level 2 of the data structure, instead of estimating them simultaneously. The two-step method has been gaining popularity, particularly in political science, as an alternative to the multilevel regression model. It has already been used to analyse the PIAAC data, due to its relatively few country cases. Examples include Heisig and Solga (2014) and Dämmrich et al. (2015).

The basic form of the first-stage model is to estimate *k* country-specific regressions (at level 1 of the data structure), wherein the gender difference in adult numeracy is analysed within countries. The gender coefficient in these models represents the average score difference in numeracy between men and women within a given country. Variables are added sequentially, to assess their contribution to explaining the gender difference in adult numeracy:

(6) $y_i = \beta_0 + \beta_1\, male_i + \beta_k\, X_i + \varepsilon_i$

Where y_i is numeracy skill score for individual *i*, y_i is a linear combination of the constant β_0 and *i*'s values on different combinations of covariates x_1 to x_k, multiplied by coefficients β_1 to β_k and an unobservable error term, ε_i. For example, in Chapter 4, numeracy score is modelled as a linear combination of gender, plus education level and field, and socio-demographic variables.

In the second step, in Chapter 6, the *k* gender coefficients from the first-stage models are used as outcome variables in a single, country-level regression model with 16 cases (at level 2 of the data structure)[11]. Country-specific characteristics are the independent variables. We are interested in the effects of country-level variables z_g on the slope of gender, $\beta_1\, gender_{ig}$, so we regress $\beta_1\, gender_{ig}$ on z_1 to z_G.

The main advantage of the two-step method is that it does not assume that that the effects of covariates at the individual level are the same in all countries (Heisig et al. 2017). Rather, it shifts the focus to differences between countries in the effects of these individual-level variables, which becomes a substantive part of the analysis. In this thesis, part of the interest is in whether differences between countries are altered when controlling for theoretically relevant individual-level variables. Therefore, a comparison of the effect of individual-level variables across countries is highly appropriate. In a conventional multilevel model, most of the country-specific detail on individual-level relationships is lost.

The second advantage of the method is that it does not impose assumptions on the distribution of country-level error terms (Heisig et al. 2017). There is a potential loss of precision in the fact that the dependent variable in the second stage is estimated, rather than directly measured. However, this is

[11] Analysis could not be carried out using the full 20 countries for reasons that are described in Chapter 6.

accounted for using a method outlined by Lewis and Linzer (2005), which weights the results using the standard errors of the first-stage estimates. This is achieved using the Stata package 'edvreg'[12]. The method is also very well suited to studying cross-level interactions, which is a key aim with this analysis, since I am interested in how the gender coefficient varies according to country-specific characteristics (rather than explaining cross-country variation in numeracy scores per se). The method is also very flexible because one can, for example, use different types of models in the first and second stages.

However, the two-step strategy has several limitations. It is less efficient in that estimation is not simultaneous for both levels but proceeds in two steps. Secondly, since a model is separately estimated for each country in the first step, there is an assumption regarding independence of estimates across countries conditional on the covariates included in the first step. This assumption might not always be tenable. The literature suggests that Bayesian methods of estimation and inference may perform better in comparative analysis with small numbers of countries (Bryan & Jenkins 2016), and this has been explored successfully in other studies using the PIAAC data (Heisig & Solga 2015).

Post-estimation in the first stage

When assessing the role of variables added sequentially to a regression model, one can simply 'eyeball' the coefficients to see if they look substantially different. However, to assess the change in coefficients more formally, various methods are available for linear and logistic models. For linear (OLS) regression models, whether any change in coefficients across models is statistically significant can be calculated using post-estimation tests (Clogg et al. 1995). Unfortunately, this type of post-

[12] I am grateful to Jan Paul Heisig for providing this package and an explanation of the procedure.

estimation is not compatible with the special programmes written for analysing PIAAC variables ('repest' and 'piaactools'). Therefore, these tests have been conducted using individual plausible values (after weighting the data correctly). This means that the tests are not conducted on the exact coefficients that are shown in the tables. Where a change in gender coefficient between was statistically significant across all ten plausible values at the 5% level or below, it was marked in bold on the tables. These tests were conducted using the Stata module 'suest'.

Estimating the statistical significance of a change in an odds ratio across stepwise logistic models is more complex. The approach outlined above is not appropriate because the coefficients and odds ratios in logistic models are influenced not only by the relationships in the data, but also by the amount of error variance (or unobserved heterogeneity) in each model. The Karlson, Holm, and Breen (KHB) method allows one to compare the odds ratio across nested models under an identical level of unobserved heterogeneity (Karlson et al. 2012). This was implemented for the logistic models in chapters 4 and 5 using the Stata command 'khb' (Kohler et al. 2011; Karlson et al. 2012). However, again, this command cannot be integrated with the programs designed to analyse PIAAC data. Therefore, a similar approach was taken, conducting the KHB analysis for all plausible values and combining the results[13].

[13] I consulted with experts on analysing the PIAAC data in Stata, who advised this as a reasonable approach (Francois Keslair and Maciej Jabukowski).

3. Gender and adult numeracy across OECD countries

3.1 Introduction

The purpose of this thesis is to shed light on potential explanations for gender differences in adults' numeracy skills. However, before embarking on this task, it is necessary to fully describe the nature of the differences. This descriptive work is particularly necessary because, while there is an existing body of literature describing gender differences in numeracy and related skills, there is no consensus on their magnitude, location, and statistical or practical significance (Halpern et al. 2007; Miller & Halpern 2014). Meanwhile, the OECD PIAAC reporting on gender is brief, presenting only differences in mean scores (OECD 2013a). Subsequent analysis has explored gender differences across the distribution, but only for specific age groups (OECD 2015). Other analyses of average gender differences have mainly focused on younger adults, rather than examining differences across the full adult age range (Arora & Pawlowksi 2017; Borgonovi et al. 2017). Overall, this chapter seeks to clarify the quantitative size and practical significance of gender differences in adult numeracy across the full adult age range, across the performance distribution, and across 21 countries in PIAAC. To do so, the chapter tests whether hypotheses from the previous literature on gender and numeracy apply to the data on adult numeracy from PIAAC. The chapter thereby contributes to the ongoing debate on gender differences in test scores, with a novel focus on adults, and identifies directions for further research. Throughout the chapter, results are presented separately for each country, enabling commentary on cross-country differences.

The chapter aims to answer the following research questions:

A1: How large are gender differences in adult numeracy?

A2: How do gender differences in adult numeracy evolve across the life course?

A3: How do gender differences in adult numeracy vary across the performance distribution?

3.2 Chapter outline

The rest of the chapter is structured as follows. Section 3.3 briefly reviews the now extensive literature on gender, numeracy and related skills. This review covers what is known about the size of gender differences, how gender differences evolve across the life course, and how gender differences vary across the performance distribution. This background is used to develop hypotheses. Section 3.4 explains the methodology used in the empirical analysis. Section 3.5 contains the empirical results and section 3.6, a discussion. The conclusion, in section 3.7, identifies priorities for further research.

3.3 Prior research on gender, numeracy and related skills

How large are gender differences in adult numeracy?

The size of gender differences in numeracy and related skills has been a matter of considerable debate for decades. Some scholars suggest that gender differences are negligible, and that research would do better to focus on similarities between the genders (Frost et al. 1994; Spelke 2005; Hyde et al. 2008; Lindberg et al. 2010; Ball et al. 2013; Hyde 2014). However, recent international studies still find substantial and significant male advantages in numeracy and related skills in a range of age groups and country contexts. For example, Bedard and Cho (2010) find sizeable differences in mathematics scores among nine- and ten-year-olds across OECD countries. Lohman and Lakin (2009) find consistent gender differences in adolescents' quantitative abilities across grades, cohorts, and test versions the United Kingdom and United States, while results from the 2015 PISA study found male advantages in mathematics across a range of country contexts (OECD 2016). The fact that such studies are based on nationally representative samples, use robust measures of numeracy, and show gender differences in a range of country contexts calls into question the claim that, on the whole, gender differences are negligible. These findings are particularly notable since girls consistently outperform boys in reading (OECD 2016) and in almost all other aspects of education (Buchmann et al. 2008; McDaniel 2012).

However, they also show substantial variation across countries, which makes it difficult to make definitive, universal claims about the size of the gender difference.

Even if gender differences are not quantitatively large, particularly compared to the influence of other social characteristics on skills, this does not mean that they will not have real-world consequences. For example, research shows that numeracy skills are robustly rewarded in the labour market. A one standard deviation increase in numeracy skills is, on average, associated with, on average, a 17 per cent increase in log hourly wages (Hanushek et al. 2015). This suggests that even moderate gender differences in numeracy could be associated with income disparities. The association between numeracy and health and wellbeing-related outcomes (Sabates & Parsons 2012) suggests that gender differences in numeracy could also have consequences beyond the economic domain.

The foregoing discussion demonstrates that there are no straightforward answers to the question 'how large are gender differences in numeracy?'. There is much variation between studies, and the size of the difference can be expressed in different metrics, alongside different contextual factors (Halpern 2012: 375). The answer to the question is often based on the existing convictions of researchers – whether they wish to play down differences in order to emphasise that men and women have equal potential to participate in STEM fields (e.g. Spelke 2005; Hyde et al. 2008; Lindberg et al. 2010), or to highlight the surprising persistence of gender differences (Lohman & Lakin 2009; Lakin 2013). Furthermore, there is almost no evidence on gender differences in numeracy in contemporary adult populations. These considerations mean that establishing the size and significance of gender differences in adult numeracy, both quantitatively and contextually, is a critical task for this chapter.

How do gender differences in numeracy vary by age group?

As the previous section showed, most existing knowledge on the size and significance of gender differences in numeracy and related skills is based on studies of children and adolescents. Knowledge on gender and *adult* numeracy is more limited. Yet it is important to understand how gender differences in numeracy evolve beyond adolescence, for two main reasons. Firstly, establishing that gender differences in adult numeracy are distinct from gender differences in mathematical achievement in childhood and adolescence is crucial to framing the debate. If gender differences in numeracy were very similar to differences already established in children and adolescents, this would indicate that factors earlier in the life course – for example, gender socialisation, exposure to mathematics learning through childhood – would be the most important explanations. In contrast, establishing that gender differences vary through the life course, and particularly, that they increase from adolescence to adulthood, suggests that explanations may be found among experiences in adult life. Moreover, establishing that gender differences in numeracy are larger in older than younger generations may suggest cohort effects relating to changes in the gender stratification of education or other life chances over time (Weber et al. 2014).

Efforts to establish the life course evolution of gender differences in an international context are hampered by a lack of appropriate multi-country data. Recent studies have been based on socially selective, single-country samples (Lippa et al. 2010), or only on older European adults, using limited measures of numeracy (Weber et al. 2014). ALL (The International Adult Literacy and Life Skills Study 2003) is now rather outdated, and although the British birth cohort studies (the National Child Development Study, NCDS, initiated in 1958, and the British Cohort Study, initiated in 1970) contain high quality measures of adult numeracy, the data relate only to specific birth cohorts and cannot be generalised beyond Britain. Moreover, the skills assessments were not part of the survey at every wave, so it is not possible to compare gender differences across multiple life stages.

Despite their drawbacks, the consensus from these studies does seem to be that gender differences in numeracy increase through the life course. Weber et al. (2014) find that gender differences are most pronounced among the oldest adults in the SHARE study. Analysis of ALL showed that in the majority of countries the gender difference in numeracy was larger in older adults than in the general population (OECD & Statistics Canada 2011). Analysis of the British birth cohort studies revealed that adult skills cannot be fully explained by early life experiences – including the striking result that, by age 34, over 60% of the variation in adult numeracy could not be explained by mathematics skills in early life - or by engagement in the labour market in early adulthood (Bynner & Parsons 1998). Moreover, the male advantage in numeracy established in Bynner and Parsons (1998) could not be explained by these earlier factors. Meta-analyses based primarily on US studies suggest that gender differences in mathematical and spatial skills increase with age (Hyde et al. 1990; Voyer et al. 1995).

While PIAAC provides the most reliable, up-to-date source for studying gender differences in numeracy among different generations of adults, age group comparisons based on cross-sectional data are always fraught with difficulties and should be undertaken and interpreted with caution. This is because of the conflation of 'age effects', 'period effects', and 'cohort effects' (Desjardins & Warnke 2012; Paccagnella 2016). While some studies claim that men's abilities are more susceptible to age-related decline than women's (Maylor et al. 2007), longitudinal, and meta-analytic studies show that overall cognitive functioning declines at similar rates for men and women (Meinz & Salthouse 1998; Aartsen et al. 2003). It is more likely, then, that any age–gender interactions are more likely the result of cohort or period effects. Marked declines in gender inequality in educational participation over the course of the 20th century (Breen et al. 2010) and the associated 'rise of women' in higher education (Vincent-Lancrin 2008; DiPrete & Buchmann 2013) could play an important role in the expression of gender differences in different age groups (Weber et al. 2014). However, longitudinal data are essential to disentangle age, period, and cohort effects.

This brief review makes it clear that establishing the life course and generational evolution of gender differences in numeracy is challenging and fraught with data constraints. However, based on meta-analyses, earlier age group comparisons, and analysis of the British cohort studies data, it seems reasonable to expect that gender differences in adult numeracy will be larger in older age groups than in younger age groups. This leads to the following hypothesis:

H1. Gender differences in adult numeracy are larger in older age groups compared to younger age groups.

How do gender differences in adult numeracy vary across the performance distribution?

Studies on gender, numeracy and related skills have consistently found differences at the extremes of the distribution, among low and high achievers. Sometimes, these differences are larger than average score differences (Hedges & Nowell 1995; Hyde 2005; Strand et al. 2006; Halpern et al. 2007; Lohman & Lakin 2009; Pargulski & Reynolds 2017). Males tend to be over-represented in the high achieving 'right tail', although the magnitude of this varies across studies (Ceci et al. 2009; Ceci & Williams 2010). Lakin (2013) shows that, among adolescents, these right-tail differences may be even more resilient than mean differences, finding that they increased between 1984 and 2011, even though mean differences declined in the same period. Findings such as these have led some researchers to conclude that reporting only mean differences could be misleading (Feingold 1992; Penner & Paret 2008; Sohn 2012; Pargulski & Reynolds 2017). Moreover, gender differences in high level mathematical skills are often considered more important than mean differences due to their potential effects on the so-called STEM pipeline (Ceci & Williams 2010; Ellison & Swanson 2010; Zhou et al. 2017) and the fact that high level numeracy skills are rewarded throughout the labour market (Sells 1978; Hanushek et al. 2015; Adkins & Noyes 2016).

While gender differences at low levels of numeracy and related skills are sometimes less pronounced, and therefore overlooked, they are still observed in many studies (e.g. Penner 2008). The effects of poor numeracy are potentially far more negative. This is reflected in policy concern about low skill levels among adults across countries (Windisch 2016). Poor numeracy, even when accompanied by competent literacy, has been shown to be associated with a range of negative adult outcomes for women, including low employment rates, less access to in-work training, lower earnings, poorer physical health and wellbeing, and lower social participation (Bynner & Parsons 1997a; Hanushek et al. 2015). Gender imbalance in the 'left tail' of numeracy could thereby entrench gender inequality in a range of fields. In this sense, gender differences at the mean and at each distributional extreme should be considered separate indicators with applicability to different sections of the population, and left tail differences should merit equal attention.

While some studies find that the over-representation of males at high skill levels is consistent across countries (Machin & Pekkarinen 2008), Penner (2008) finds that distributional variation is a more complex phenomenon, and a variety of distributional patterns are possible. For example:

(1) Gender differences can be stable in both tails of the distribution and thus can be a reasonable reflection of the mean difference.
(2) Gender differences can grow more extreme in *both* tails of the distribution.
(3) Countries can have gender differences that are stable at the bottom but grow *more extreme at the top*.
(4) Countries can have gender differences that are stable at the top but grow *more extreme at the bottom*.

The previous literature clearly highlights the importance of studying the whole distribution when addressing gender differences in numeracy and related skills and has focused particularly on the right tail of the distribution. I therefore test the following hypotheses in relation to adult numeracy skills:

H2a. Gender differences in adult numeracy at distributional extremes are not necessarily predictable from the mean.

H2b. Gender differences in adult numeracy are larger in the 'right tail' of the distribution than in the 'left tail' or on average.

3.4 Methodology

The main variable of interest in this chapter is the PIAAC numeracy score. To recap, numeracy scores range from zero to 500 and are standardised to be internationally comparable so that the same score indicates the same level of numeracy across countries. PIAAC used a sampling method commonly used in international studies of educational attainment, whereby each respondent completes a subset of test items from the total pool of potential test items, and ten 'plausible values' are computed for each participant based on an item response model. Throughout the analysis, results are combined across these 'plausible values' using the Stata 'repest' package, developed by Avvisati and Keslair (2016). The other variables (age, immigrant status, parents' education) were reported by PIAAC participants as part of the background questionnaire and are described in further detail in Chapter 2.

Here I describe the analytical methods used to answer each of the research questions.

How large are gender differences in adult numeracy?

There are several ways of establishing the extent to which gender differences in average scores are large and important enough to be of practical significance. A typical way of quantifying such differences is to use an 'effect size' (Cohen 1988). The effect size, described in greater detail in section 2.4.1, indicates how far the mean numeracy scores of men and women are different from one another in standard deviation units. This provides a standardised measure of the mean difference between male and female scores, which is not biased by the distribution of scores in the sample (which may be the case if one uses only a point score difference). Effect sizes range between 0 and 1.

Another way to establish the importance of gender differences in adult numeracy is to compare them to differences based on other characteristics, and to express them in terms of other meaningful quantities. Three main comparisons are made:

- *Comparison of gender differences in adult numeracy to differences by immigrant status and socio-economic background.*
    - Differences in adult numeracy based on immigrant status are calculated as the difference in numeracy scores between first generation immigrants and those from non-immigrant backgrounds, presented as an effect size.
    - Differences in adult numeracy based on socio-economic background are calculated as the difference in scores between adults with relatively low-educated fathers (ISCED 1–3) and those with relatively highly educated fathers (ISCED 5–6[14]), presented as an effect size.
- *Gender differences in adult numeracy expressed as percentage point differences in log hourly wages.* In a 2015 paper, Hanushek and colleagues calculated, for each country involved in PIAAC, the wage return associated with a one standard deviation increase in numeracy score[15]. Since the effect size corresponds to a standard deviation unit, one can easily calculate the expected wage return associated with the gender difference in each country, by multiplying the gender effect size by the estimated wage return. This calculation expresses the gender difference in numeracy in terms of a percentage point difference in wages, to

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[14] ISCED levels are explained in Chapter 2.

[15] Hanushek et al.'s (2015) analysis was based on a sample of prime age working adults. This would not necessarily correspond to the wage return to skills in the sample as a whole. However, Hanushek et al.'s wage return calculations are consistent across multiple model specifications and sub-samples, suggesting that the wage return to a standard deviation increase in numeracy is relatively robust across different sub-groups in a population.

highlight the potential economic cost associated with women's disadvantage in numeracy in each country.

How do gender differences in numeracy vary across by age group?

The main method used to answer this question is a descriptive comparison of mean and distributional gender differences across five 10-year age groups. Table 3.1 shows the age groups and birth years represented in the PIAAC study.

Table 3.1 Age groups and birth cohorts, PIAAC 2012

Age group in 2012	Birth cohort
16–24	1988–1996
25–34	1978–1987
35–44	1968–1977
45–54	1958–1967
55–64	1948–1957

To compare gender differences between adolescence and adulthood, I also construct a 'synthetic cohort', using data on mathematics achievement from PISA 2003. The students who participated in PISA 2003, at age 15, would have been 24 years old at the time of PIAAC 2012. To ensure a large enough sample, 23- and 25-year-olds from the PIAAC dataset were included in the comparison. Several other studies have employed this 'synthetic cohort' approach to take advantage of the links between PIAAC and PISA and to comment on life course variation in skills between adolescence and early adulthood (Lundetrae et al. 2014; Green et al. 2015; Borgonovi et al. 2017). However, although this comparison is revealing, one should also bear in mind the differences in assessment frameworks between the two studies (Lundetrae et al. 2014; Borgonovi et al. 2017).

How do gender differences in adult numeracy vary across the performance distribution?

The first method used to show differences across the distribution is to compute effect sizes across the country-specific adult numeracy score distribution, from the 5th to the 95th percentile. Using these effect sizes at percentiles allows direct comparison across the distribution, including with the mean difference. PIAAC also provides international benchmarks of what constitutes 'high' and 'low' numeracy skills. To be classified as 'high skilled' an individual needs to score at or above the 75th percentile, 304 points. To be classified as low skills, an individual needs to score 238 points or below. Further description of these benchmarks can be found in Chapter 2 (section 2.4.1). To assess differences at these international benchmarks of high and low numeracy levels, logistic regression analysis was run for each country with gender (male) as the only predictor. The resulting odds ratios represent the odds for males (compared to females) of having high or low levels of adult numeracy.

3.5 Results

3.5.1 How large are gender differences in adult numeracy?

Table 3.2 shows the average difference in adult numeracy scores in the whole adult sample, by country. Countries are ordered according to their effect size. There is a male advantage in all countries, although the difference is not statistically significant in the Slovak Republic and Poland. Effect sizes vary widely between countries, ranging from 0.04 to 0.33. The effect sizes observed in most countries can be considered moderate according to Cohen's (1988) guidelines. However, the degree of variation is notable, with Estonia, the Slovak Republic, and Poland exhibiting negligible differences, while the male advantage amounts to a considerable one third of a standard deviation in Germany, the Netherlands, and Belgium.

Table 3.2 Gender differences in mean numeracy scores and descriptive statistics, adults aged 16-65, PIAAC 2012

Country	N	Overall mean - numeracy	SD-numeracy	Mean - female	Mean - male	Difference male-female	Effect size
Netherlands	5,170	280.35	51.07	271.94	288.68	16.74	0.33
Germany	5,465	271.73	53.07	262.99	280.28	17.29	0.33
Belgium	5,463	280.87	50.13	272.61	288.97	16.36	0.33
Austria	5130	276.29	47.61	269.50	283.19	13.68	0.29
Norway	5,128	281.83	49.64	274.39	288.92	14.53	0.29
Japan	5,278	288.22	43.96	282.01	294.37	12.35	0.28
UK	8,892	263.02	53.23	256.06	270.09	14.04	0.26
Canada	26,683	265.24	55.60	257.94	272.54	14.60	0.26
Spain	6,055	247.84	49.10	241.44	254.15	12.71	0.26
Denmark	7,328	281.63	47.28	275.57	287.71	12.14	0.26
USA	5,010	252.84	57.03	245.96	260.05	14.09	0.25
Sweden	4,469	279.05	54.88	272.17	285.73	13.56	0.25
Korea	6,667	264.73	44.39	259.50	270.03	10.52	0.24
Ireland	5,983	255.59	53.66	249.76	261.68	11.92	0.22
Italy	4,621	247.66	49.37	242.31	253.07	10.76	0.22
Czech Republic	6,102	275.93	43.49	271.43	280.34	8.91	0.20
Finland	5,464	282.23	52.21	277.11	287.29	10.18	0.20
France	6,993	257.12	53.89	252.22	262.21	10.00	0.19
Estonia	7,632	273.82	44.84	270.73	277.20	6.46	0.14
Poland	9,366	263.64	46.85	261.19	266.21	5.02	0.11
Slovak Republic	5,723	275.74	47.37	274.69	276.80	2.11	0.04
Average							0.23

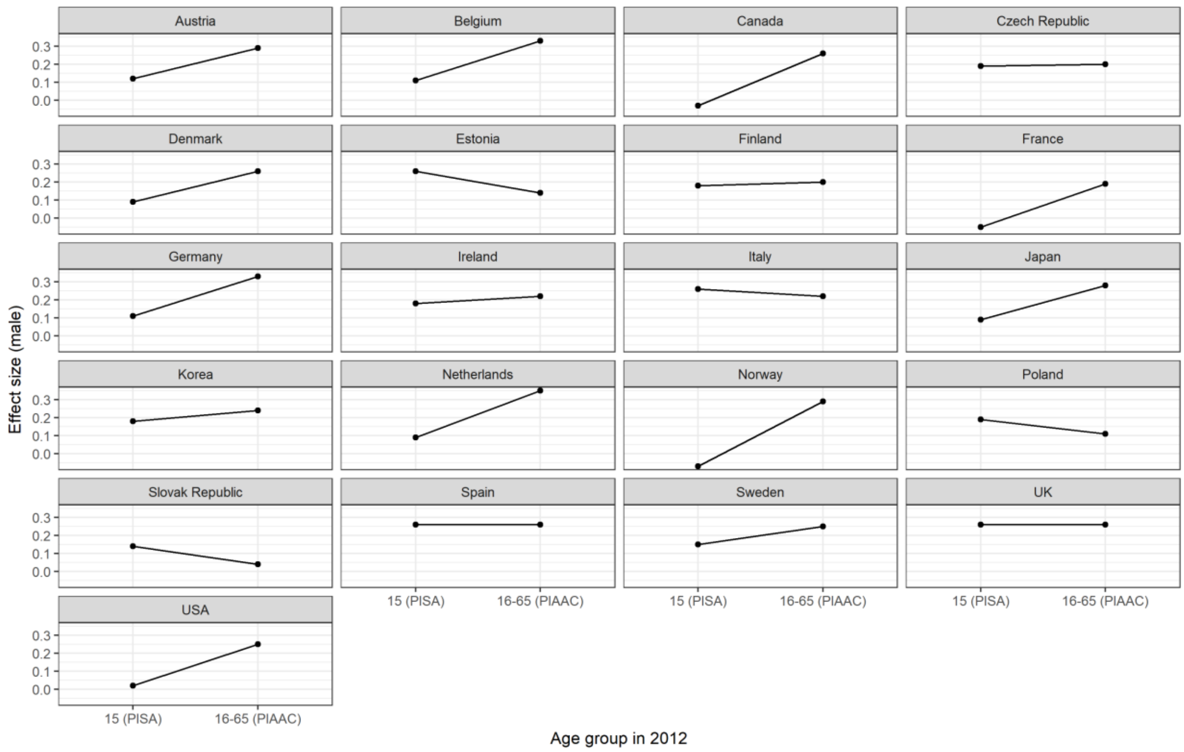
Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. UK = England and Northern Ireland.

Figure 3.1 provides a comparison with the gender difference in 15-year-olds' mathematics achievement, also assessed in 2012 as part of the PISA study. While the effect sizes are similar across the two studies in the UK, Italy, Spain, the Czech Republic, and Finland, in general the gender difference in adult numeracy is larger than the gender difference in teenagers' mathematics achievement (see, notably: Austria, Belgium, Canada, Denmark, France, Germany, Norway). Norway, Canada, France, and the USA show virtually no gender difference among teenagers. Conversely, in

Poland, Estonia, and the Slovak Republic, the gender difference in teenagers' mathematics achievement is larger than the adult gender difference in numeracy.

This suggests that in most countries, previous studies may have under-estimated the scale of the problem, since gender differences in numeracy among the broader adult population are not well-represented by differences among teenagers. On the other hand, this could also suggest that countries such as Austria, Belgium, Canada, Denmark, France, Germany, Norway, and the USA have been effective at reducing gender differences in numeracy among 15 year olds in 2012, while they persist among adults.

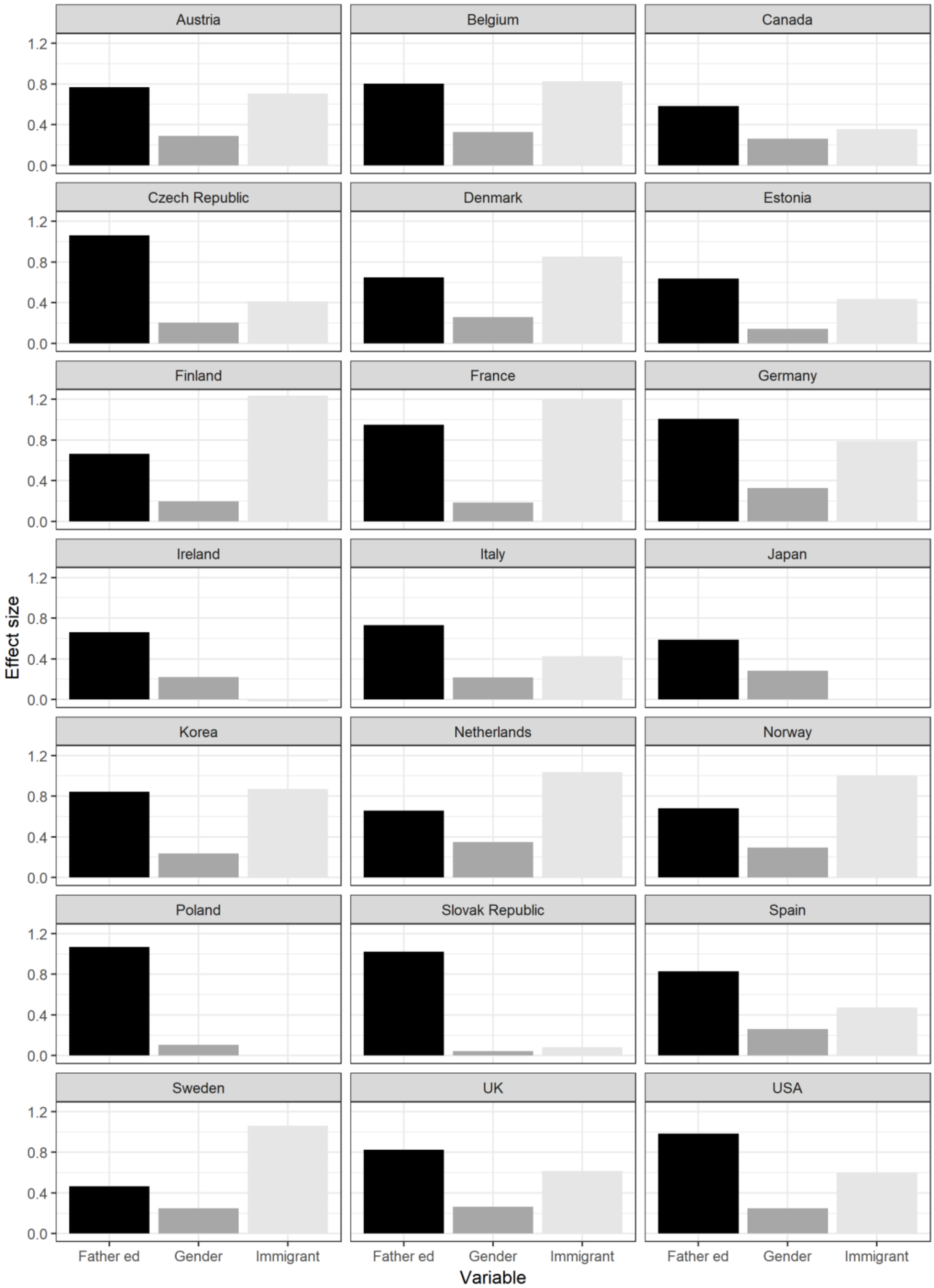
Figure 3.1 Effect sizes, PISA Mathematics and PIAAC Numeracy, 2012



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. UK = England and Northern Ireland**.**

Figure 3.2 shows how the effect size for gender compares to effect sizes based on social background (measured by father's education level, comparing the scores of those with high educated fathers compared to the scores of those with low educated fathers) and immigrant status (first generation immigrants compared to all others, including second-generation immigrants). In all countries, the gender difference in adult numeracy is smaller than differences based on these other important social characteristics, which have been highlighted as important dimensions of adult skills inequality in previous studies (Green et al. 2015; Levels et al. 2017). In comparison to these influences, the gender difference is relatively minimal. However, although the influence of gender may be small compared to immigrant status and social background, it also exerts an independent influence over and above these characteristics, as we will see in later chapters.

Figure 3.2 Influences on adult numeracy: fathers' education, gender, and immigrant status

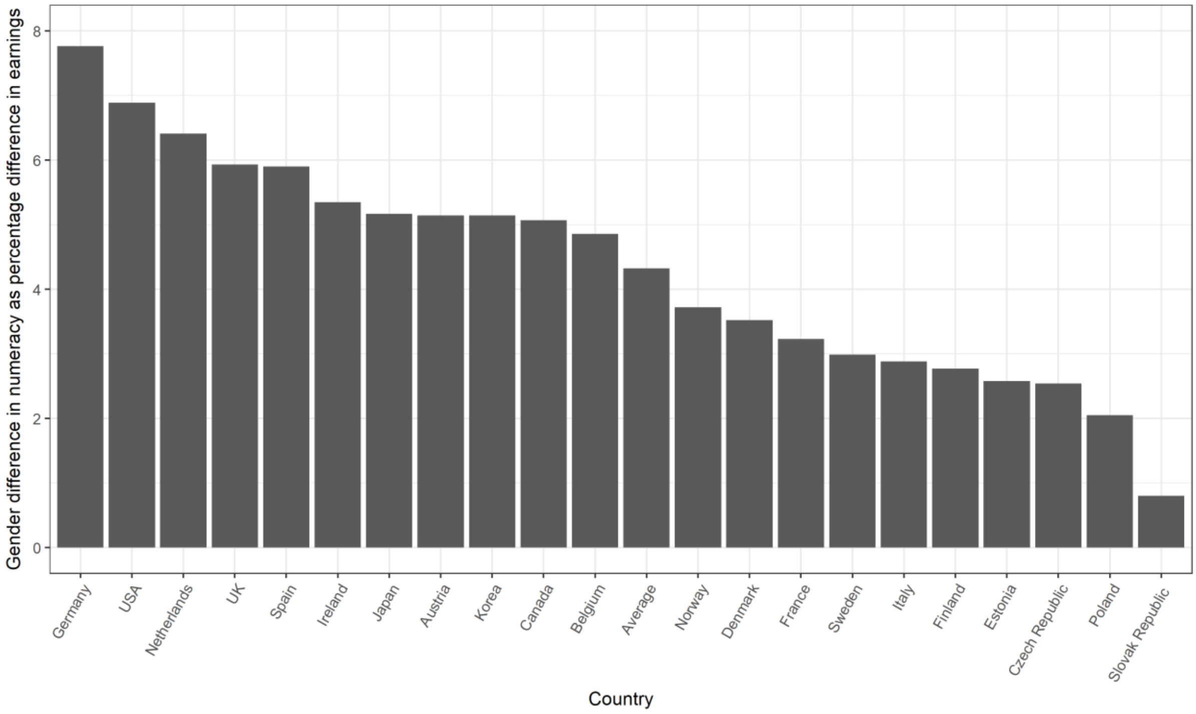


Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Note: Immigrant differences not available for Poland and Japan because the size of the immigrant population is too small.

Although the gender difference is quantitatively small, particularly when compared to differences based on other social characteristics, this does not mean that it will not have real-world consequences. Figure 3.3 shows the gender difference in numeracy expressed as a percentage point difference in wages, calculated using the country-specific estimates of wage returns to numeracy skills from Hanushek et al. (2015)[16]. This shows that the gender difference in numeracy is equivalent to around a four per cent difference in hourly wages. This is as high as 7% in the USA and 8% in Germany. It should be acknowledged that these patterns are affected both by the size of the gender difference in numeracy and by the relative wage returns to numeracy in different countries. Wage returns to skills are relatively large in the USA and Germany and relatively small in Norway and Finland, for example (see Appendix Table A3.1).

[16] These estimates were calculated using the estimated wage returns to PIAAC numeracy skills by Hanushek et al. (2015, Table 2). These estimates are reproduced in the Appendix to Chapter 3 (Table A3.1).

Figure 3.3 Gender difference in adult numeracy expressed as a percentage difference in earnings, 21 OECD countries, PIAAC 2012



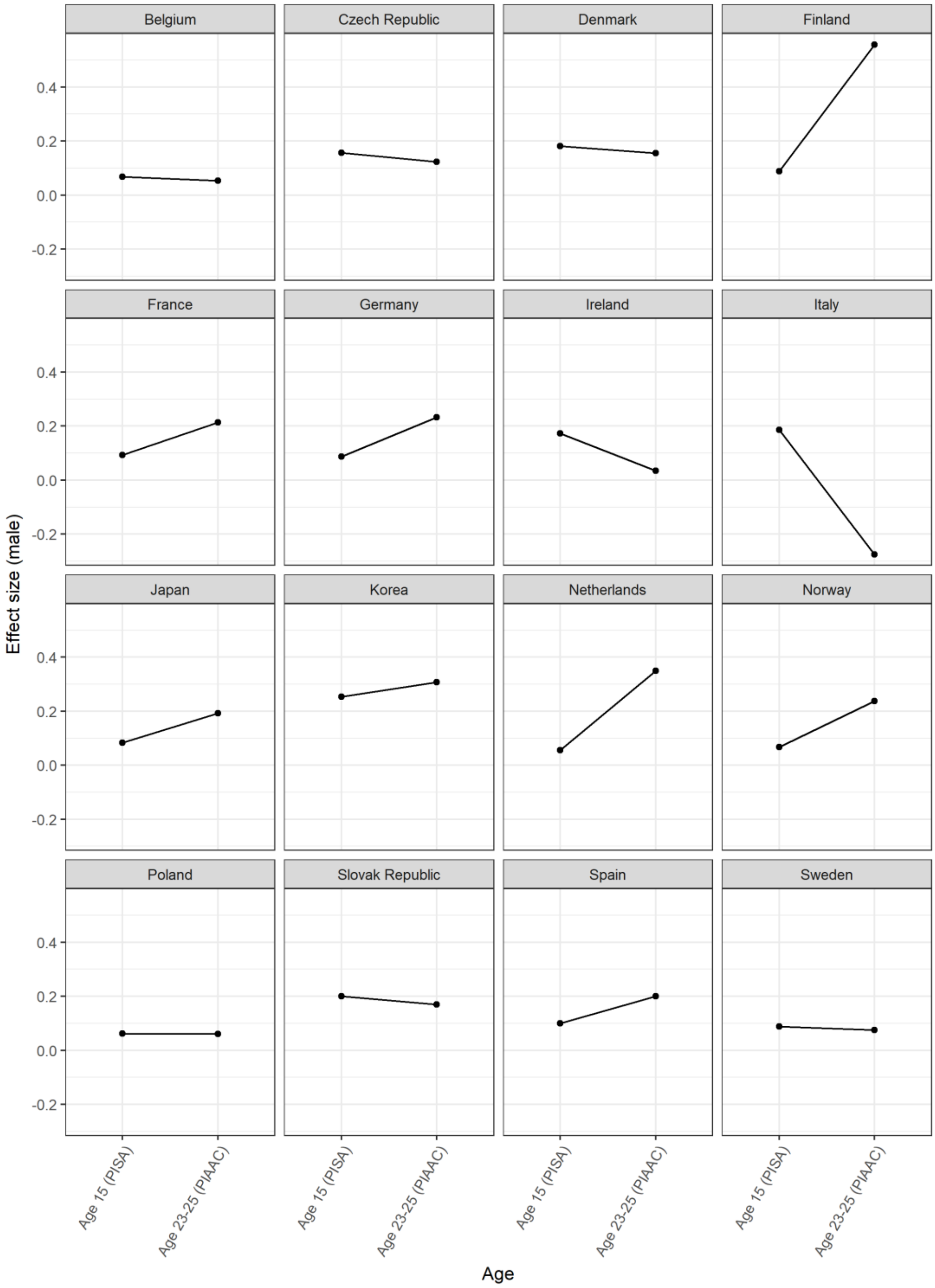
Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. UK = England and Northern Ireland.

The economic consequences of gender differences in adult numeracy are confirmed by the finding that a portion of the gender wage gap can also be attributed to gender differences in skills. Hanushek et al. (2015) found that, on average, around a fifth of the gender wage gap in the pooled sample was attributable to gender difference in numeracy. This was particularly the case in Belgium, Spain, the UK and Germany, where more than one third of the gender wage gap in was attributable to gender skill differences (Hanushek et al. 2015).

3.5.2 How do gender differences in adult numeracy vary by age group?

Figure 3.4 shows the results from a synthetic cohort comparison between the gender difference in 15-year-olds' performance in PISA mathematics 2003, and the gender difference in PIAAC numeracy among the same cohort, who were 24-year-olds in 2012 (here 23–25-year-olds are used). In most countries, the gender difference is larger in PIAAC numeracy than in PISA mathematics. This increase between adolescence and early adulthood is particularly large in Finland and the Netherlands. For example, the male effect size in PISA mathematics in Finland was around 0.1. By the time this cohort reached early adulthood, the gender difference in adult numeracy was almost 60% of a standard deviation (i.e. an effect size of 0.6). However, in other countries, there is no obvious increase: the Slovak Republic, Sweden, and Belgium all show similar gender differences in adolescence and early adulthood. Meanwhile in Italy, women aged 23–25 perform better than their male counterparts in numeracy, the direct opposite to the PISA results, suggesting that women improve their numeracy between adolescence and early adulthood. These results suggest that in some countries, notably Finland, the Netherlands, and Norway, something is happening between adolescence and early adulthood which is increasing the female disadvantage in numeracy, while in other countries, this is not the case. This quasi-cohort pattern has been previously observed in Borgonovi et al. (2017).

Figure 3. 4 Synthetic cohort analysis: gender difference in PISA Mathematics (age 15, 2003) and gender difference in PIAAC Numeracy (age 23–25, 2012), selected countries



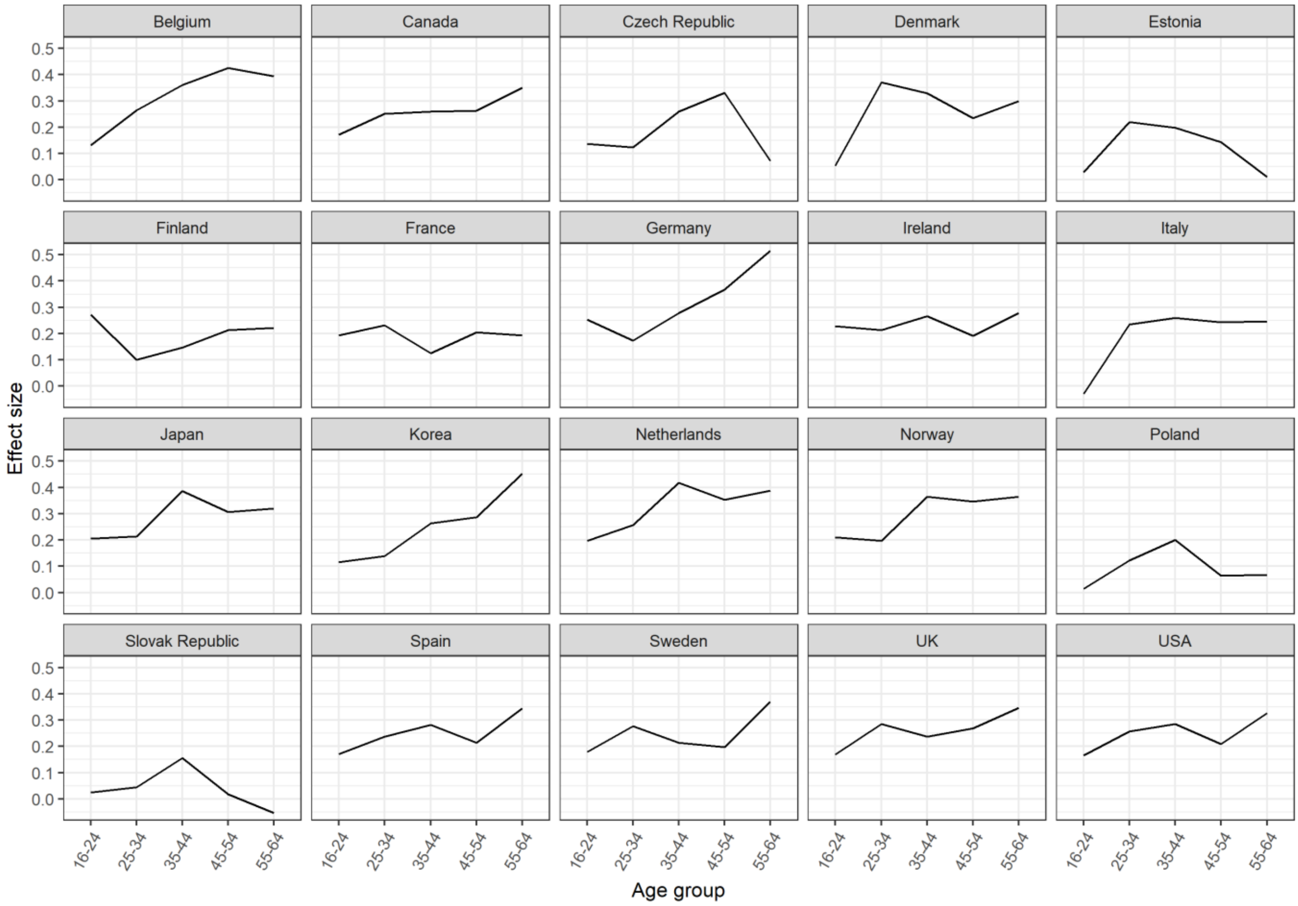
Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. Austria, Canada, Estonia, the UK, and the USA are omitted from this analysis due to lack of data.

Figure 3.5 shows the mean gender difference by age group and country (as an effect size). In general, gender differences are smallest in the younger age groups, and larger among older age group, confirming the expectations of Hypothesis H1 for the majority of countries. The age patterns in certain countries are particularly notable. While the expected age group pattern is clearly visible in countries such as Belgium, Germany, Korea, the Netherlands, and Norway, the trend is not always completely linear, and in some cases, gender differences in numeracy are relatively similar across age groups (e.g. France, Ireland). In post-Soviet countries (Estonia, the Slovak Republic, Poland, and the Czech Republic), the gender difference is larger in the middle age groups and lower or non-existent for younger and older adults. This is particularly the case in the Czech Republic, which has relatively large differences among middle age groups. In Finland, gender differences are concentrated among younger age groups, whereas the differences for those older than 45 are relatively small.

The apparent increase between adolescence and early adulthood in Finland which was observed in the synthetic cohort analysis in Figure 3.5, appears to reverse again in the 25-34 age group (i.e. when taking the average difference in these larger ten-year age groups, the gender difference is larger among 16-25 year olds than among 25-34 year olds). This is confirmed by an extra analysis by individual age (rather than age group), included in Appendix 3.2. This shows that there is a particularly large gender difference among adults aged 23-25 which then is smaller in ages 25 and above. In Italy, while there was an apparent reversal of the male advantage between adolescence and early adulthood, observed in Figure 3.5, males in their late 20s and above have a clear advantage over female counterparts. Moreover, in most countries, the scores of men and women fluctuate considerably across this age range. Average scores based on small age groups or individual ages are based on small cell sizes and patterns observed (for example in Figure 3.5 and in Appendix x) may also result from sampling variation. It is therefore difficult to say definitively that the quasi-cohort analysis reflects genuine patterns in the population.

Therefore, although the age trends observed in the data generally conform to the expectations of previous research, there are notable cross-country differences. These cross-country differences underscore the likelihood that larger gender differences in older than younger age groups in some countries do not only represent age effects, but probably incorporate cohort effects which are highly contextually specific.

Figure 3.5 Gender difference by age group and country (effect size)



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

How do gender differences in adult numeracy vary across the performance distribution?

Table 3.3 shows gender differences across the distribution, using percentiles of within-country adult numeracy scores. This shows the effect of being male from the lowest skill levels (the 5th percentile) to the highest skill levels (the 95th percentile). For most countries, the effect size increases steadily across the distribution, in line with the prediction that gender differences in numeracy are largest at the 'right tail' (Hypothesis 2b). In some cases, the gender difference at the top percentiles is considerably larger than the average difference. For example, the US shows a considerable effect size of 0.36 at the 95th percentile, while its mean effect size is 0.25. Even countries with a low average effect size, such as Poland, show a male advantage at higher percentiles of numeracy. However, some countries do not fit this pattern. For example, the Czech Republic, Germany, Sweden, and Korea show relatively large differences across the entire distribution of scores, including relatively large differences at the 5th and 10th percentiles, showing that women are disproportionately likely to have the lowest levels of numeracy in these countries. This suggests that the hypothesis that gender differences increase across the distribution of scores is not always applicable, and a variety of distributional patterns are possible. There is therefore mixed support for Hypothesis H2b. However, these results confirm the general expectation that gender differences at distribution extremes do not necessarily mirror average gender differences (Hypothesis H2a), being considerably larger than mean differences in some cases.

Table 3.3 Effect sizes (male) across percentiles, adults aged 16–65, PIAAC 2012

Percentile	Austria	Belgium	Canada	Czech Republic	Denmark	Estonia
5	0.18	0.17	0.22	0.22	0.07	0.01
10	0.21	0.23	0.20	0.21	0.09	0.07
25	0.25	0.32	0.23	0.19	0.17	0.11
50	0.31	0.33	0.27	0.22	0.25	0.13
75	0.31	0.35	0.29	0.21	0.28	0.17
90	0.32	0.37	0.30	0.22	0.31	0.23
95	0.33	0.39	0.33	0.19	0.31	0.25
	Finland	**France**	**Germany**	**Ireland**	**Italy**	**Japan**
5	0.02	0.22	0.34	0.01	0.18	0.13
10	0.09	0.18	0.31	0.16	0.16	0.14
25	0.17	0.14	0.32	0.21	0.14	0.23
50	0.21	0.19	0.33	0.23	0.21	0.30
75	0.25	0.24	0.33	0.26	0.26	0.33
90	0.27	0.24	0.32	0.32	0.30	0.37
95	0.27	0.22	0.33	0.33	0.33	0.40
	Korea	**Netherlands**	**Norway**	**Poland**	**Slovak Republic**	**Spain**
5	0.29	0.22	0.09	-0.21	0.02	0.15
10	0.26	0.26	0.27	-0.13	-0.03	0.24
25	0.21	0.36	0.27	-0.02	-0.01	0.22
50	0.21	0.38	0.32	0.07	0.04	0.23
75	0.23	0.36	0.34	0.13	0.09	0.31
90	0.26	0.38	0.36	0.19	0.09	0.35
95	0.24	0.38	0.36	0.23	0.15	0.37
	Sweden	**UK**	**USA**			
5	0.33	0.16	0.21			
10	0.27	0.18	0.18			
25	0.22	0.21	0.17			
50	0.23	0.28	0.22			
75	0.26	0.32	0.31			
90	0.25	0.31	0.33			
95	0.26	0.34	0.36			

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. UK = England and Northern Ireland.

Table 3.4 shows gender differences at the extremes of the numeracy score distribution, using the PIAAC international benchmarks. The table shows the odds ratios of scoring above 304 points (column titled 'odds ratio: high numeracy') and below 238 points (column titled 'odds ratio: low numeracy') for men compared to women. For example, an odds ratio of 0.64 for the Netherlands means that men in the Netherlands are 36 per cent less likely to score below 238 points, compared to women. An odds ratio of 1.93 means that men are almost twice as likely as women to score above 304 points, the PIAAC benchmark for high numeracy.

Although the countries with above average mean differences (for example, the Netherlands, Germany, and Belgium) also tend to have relatively large differences at the distribution extremes, and vice versa, they do not always match up. For example, the Czech Republic has a relatively low effect size at the mean of 0.20. Despite this, men are less likely to score at the lowest levels of numeracy skills (odds ratio 0.64). Similarly, men in Spain and Italy have highly disproportionate odds of scoring at the highest levels of numeracy (odds ratios 2.25 and 2.06, respectively), although the mean gender difference is around the average in both countries. This demonstrates once again that the mean difference may not always provide a good summary of the magnitude of the gender difference in adult numeracy. These results also show that left-tail differences are important in their own right and may represent a separate indicator regarding the relative numeracy skills of men and women in a given population.

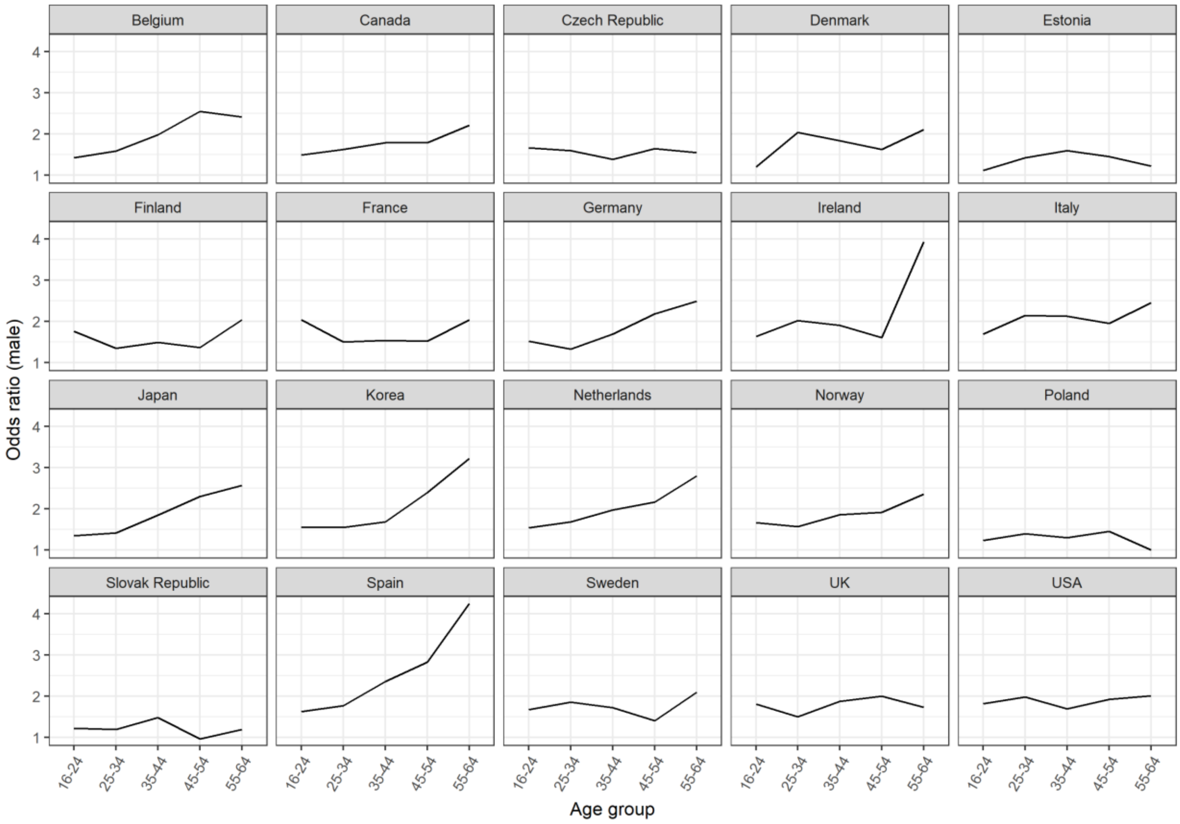
Table 3.4 Odds ratios, adults aged 16–65, PIAAC 2012

Country	Odds ratio: high numeracy	Odds ratio: low numeracy
Belgium	1.91	0.61
Canada	1.74	0.69
Czech Republic	1.58	0.64
Denmark	1.71	0.78
Estonia	1.40	0.80
Finland	1.54	0.80
France	1.65	0.81
Germany	1.78	0.60
Ireland	1.91	0.66
Italy	2.06	0.74
Japan	1.80	0.74
Korea	1.74	0.73
Netherlands	1.93	0.64
Norway	1.80	0.68
Poland	1.32	0.95
Slovak Republic	1.22	1.02
Spain	2.25	0.69
Sweden	1.70	0.70
UK	1.76	0.69
USA	1.85	0.77

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium = Flanders. UK = England and Northern Ireland.

Figure 3.6 shows men's odds of reaching high numeracy skill levels (the top 25 percent of scores) across countries and age groups, compared to the odds for women. Overall, as for average differences, gender differences are larger in older age groups than in younger age groups. However, there is also more cross-country variation among the odds ratios in older age groups, and certain countries' age patterns stand out. For example, gender differences are very large in the oldest age group in Spain, Korea, and Ireland. Apart from Korea, these countries do not have large average difference in that age group. Again, the post-Soviet countries tend to have the smallest gender differences overall and the least variation across age groups.

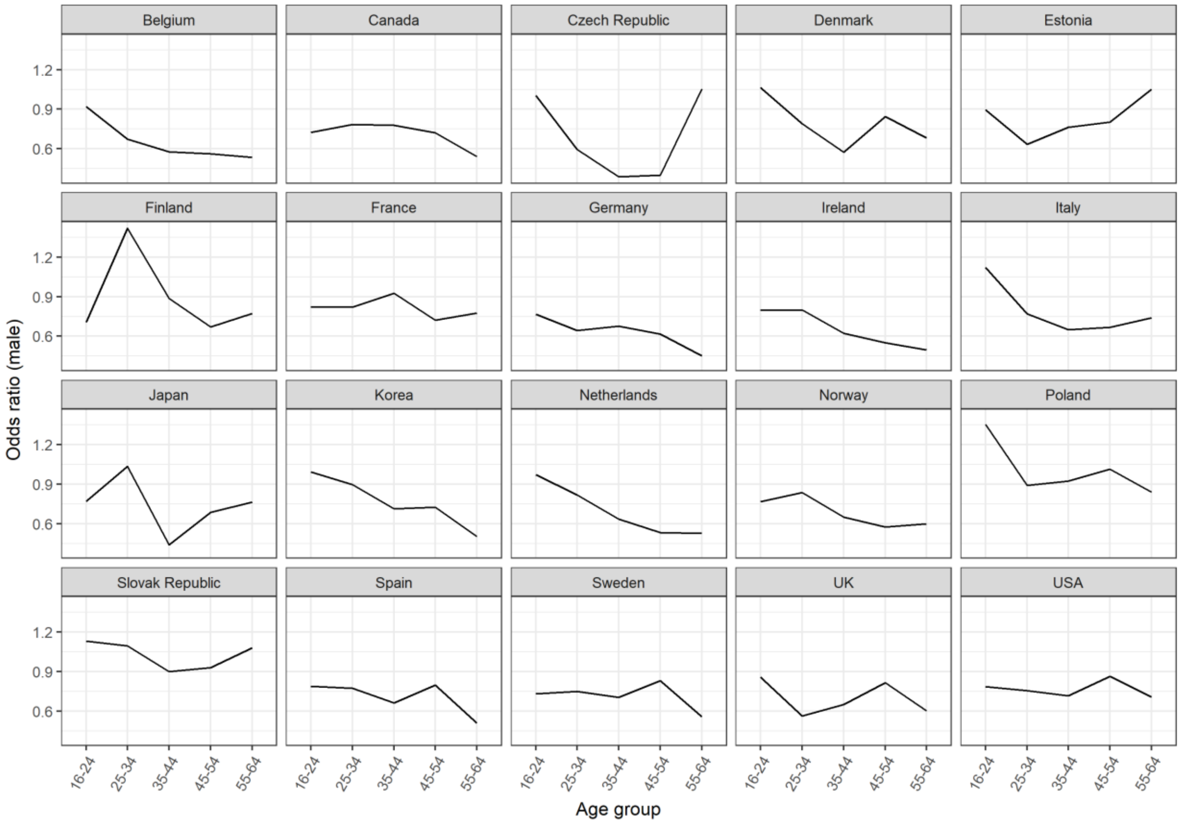
Figure 3.6 Representation of males at high numeracy levels across age groups and countries (odds ratios)



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

Figure 3.7 shows the representation of men at low numeracy skill levels (the bottom 25 percent of scores) across countries and age groups. The results are presented as odds ratios. Again, the pattern is for the over-representation of females among the lowest skilled quartile to be higher in the older age groups (represented by a downward sloping line, since a lower odds ratio represents a larger gender difference in this instance). However, there are some exceptions to this pattern. For example, in the Czech Republic, gender differences at low skill levels are most notable among middle-aged adults, while in Estonia they are most prominent among younger adults. Some countries show relatively little variation across age groups: France and the United States, for example. This shows that differences at distribution extremes may show a different age-related pattern to average differences.

Figure 3.7 Representation of males at low numeracy levels across age groups and countries (odds ratios)



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

3.6 Discussion

Despite a strong research tradition and a large literature exploring the contentious topic of gender differences in mathematical skills in children and adolescents, relatively little is known about gender differences in adults' numeracy skills cross-nationally. This chapter has therefore provided a novel contribution to the literature by establishing the importance, relevance, and context of gender differences in adult numeracy in a range of OECD countries. The chapter also had a practical purpose: to outline the basic descriptive data that provides the basis for the inferential analysis that forms the rest of the thesis. This discussion summarises the results across the three research questions outlined at the beginning of the chapter: *How large are gender differences in adult numeracy? How do gender differences in adult numeracy evolve across the life course?* and *How do gender differences in adult* *numeracy vary across the performance distribution?* Possible explanations for the patterns identified are suggested, in preparation for the following chapters.

How large are gender differences in adult numeracy?

In terms of an effect size (the difference in means expressed in standard deviation units), the gender difference in adult numeracy in the full adult sample can be considered quantitatively moderate in most countries. However, it varies substantially across countries, ranging from almost zero (in the Slovak Republic) to more than a third of a standard deviation in some cases, such as the Netherlands. These are relatively small differences compared to disparities based on socio-economic background and immigrant status. However, gender differences in adult numeracy are typically larger than gender differences in PISA mathematics, based on 15-year-olds taking part in 2012. The average effect size in PISA mathematics this sample of countries was 0.13, compared to 0.24 in PIAAC numeracy. This suggests that the data on adolescents' mathematical skills, on which most previous research is based, does not reflect the reality for the adult population. On the other hand, it also suggests that gender differences in mathematical skills are diminishing in upcoming generations.

In practical terms, the gender difference in adult numeracy is equivalent to a 4% difference in hourly wages on average, rising to 7–8% in Germany and the USA. This comparison helps to put the difference in context and show that it is likely to have real-world consequences, despite being quantitatively small compared to other performance gaps. When one considers the broader context, in which women have higher educational achievement than men in most countries, and where girls outperform boys in reading skills throughout childhood and adolescence, this is worth investigating further.

How do gender differences in adult numeracy vary across age groups?

A synthetic cohort comparison of the gender difference in PISA mathematics in 2003 and the gender difference in PIAAC numeracy in 2012 finds that in many countries, the gender difference increases in the period between age 15 and early adulthood (age 23–25). This suggests that experiences taking place in early adulthood may be important for consolidating and even increasing the male advantage in numeracy. The next chapter (Chapter 4) explores the role of educational experiences, many of which occur in this post-adolescent period, investigating whether differences in the total amount or type of education undertaken is an important contributing factor to gender differences in adult numeracy.

On average across countries, gender differences are largest in the oldest age group (55–64–year-olds) and smallest among the youngest, 16–25–year-olds. This applies for average differences, high skill differences and low skill differences. In the oldest age group (55–64), the average difference can be as high as half a standard deviation (for example, in Sweden). This age group pattern supports Hypothesis H1 and is generally consistent with predictions regarding potential cohort effects relating to educational experiences and related life course opportunities (e.g. Desjardins & Warnke 2012). Although this presents a positive picture, whereby gender differences are decreasing in successive generations, the pattern is not always linear, with substantial differences still present in younger adults. Large gender differences in numeracy among older adults are also concerning from the perspective of health and wellbeing in older adulthood, which relies in part on cognitive abilities (Stern 2002; Whalley et al. 2004). Furthermore, the expected age patterns are not always evident, for example in the post-Soviet countries.

How do gender differences in adult numeracy vary across the performance distribution?

In support of Hypothesis H2a, the gender difference at the mean is not always a good representation of gender differences across the performance distribution. In most countries, men are over-represented at the top of the country-specific distribution of numeracy scores, and women are over-represented at the bottom. This broadly reflects the findings of previous literature and provides some evidence in support of Hypothesis H2b. In most countries, the gender effect size (in the full adult sample) also increases across the country-specific distribution of numeracy scores. Interestingly, this was also the case for the Slovak Republic and Poland, where no gender difference was seen lower in the distribution, but a difference in favour of men *was* present at higher numeracy levels. However, other countries do not conform to expectations, since gender differences are similar in magnitude across the entire adult numeracy distribution. This was the case for Germany and the Czech Republic. Some countries have a consistently large gender difference in all age groups and at all points of the distribution: the Netherlands, Germany, and Belgium are notable in this regard. These results are in line with Penner (2008), who showed that a variety of distributional patterns were possible, and findings on pronounced male advantage at the 'right tail', generally based on US and UK samples, cannot necessarily be generalised globally. The results suggest that distributional patterns need to be considered when studying gender differences in adult numeracy, particularly as they vary across countries and age groups. Therefore, where practical, the empirical chapters that follow attempt to explain the gender difference in numeracy at low and high skill levels, as well as on average.

Limitations and future research

This analysis presented in this chapter has certain limitations, relating mainly to the cross-sectional nature of the PIAAC data. Because skills earlier in life cannot be accounted for, it is difficult to conclude definitively whether the age group patterns identified are the result of age, period, or cohort effects (for a full discussion of this issue, see Desjardins and Warnke, 2012, and Paccagnella, 2016). Moreover, the measure of numeracy used in PIAAC is not necessarily comparable with the results of previous studies, making comparisons with previous literature on gender and mathematical skills, and the comparison with PISA mathematics, suggestive rather than definitive. However, this chapter is mainly intended to stimulate further thinking and research on the nature and determinants of gender differences in adult numeracy in OECD countries, rather than providing explanations.

This chapter has identified several priorities for further research on gender and adult numeracy. The first is to further investigate the age pattern of gender differences. While the male advantage is typically higher among older adults, this pattern is more pronounced in some countries (e.g. Germany, Korea, and Japan). If differential cognitive ageing by gender were at play, it is not obvious why such age effects should be more severe in some countries than others. Moreover, if ageing effects were responsible, it is not obvious why certain countries would have such radically different age trends. In the post-Soviet countries (the Czech Republic, Poland, the Slovak Republic, and Estonia), for example, the largest gender differences in numeracy are among middle-aged adults, and gender differences among older adults are small. This suggests the likelihood of country-specific cohort effects. The age–gender interaction observed may result from older cohorts having encountered an educational system which disadvantaged females, either through its quality or through the quantity of education women completed. This seems a particularly likely explanation for the Netherlands, Belgium, Germany, and Japan. However, a straightforward cohort effect related to increases over time in educational attainment may not be a sufficiently comprehensive explanation, since the 'gender revolution' in education has occurred to some extent in all these countries, including the post-Soviet countries (McDaniel 2012), yet, in these countries, no such age pattern is seen. Moreover, the fact that gender differences remain among younger adults, who have experienced a gender-equal or female-advantaged education system, suggests that factors other than educational exposure are important. The next chapter investigates whether these age group patterns are attributable to generational gender inequalities in education attainment and considers how this varies across countries.

The second area for future research is the role of post-16 education and training and the early labour market in creating gender differences in adult numeracy. This research could isolate the case of the Netherlands, Finland, and Norway (where gender differences increased substantially between adolescence and adulthood), explore the paths taken by men and women in the period after compulsory education, and analyse how these contribute to consolidating or increasing skill differences. Choice of subjects or modes of study may be important to consider; such horizontal segregation in educational pathways are an important way that gender differences in educational outcomes are maintained in the context of superior female educational attainment (e.g. Alon and Gelbgiser, 2011). Future scholarship could also investigate whether gender differences in adult numeracy are linked to broader gender inequalities in the early labour market career, which have been documented by a number of recent studies (Blossfeld et al. 2015; Boye & Grönlund 2018). Since such analysis would be most effective with a longitudinal design, it is most likely to be undertaken with data from single countries (although longitudinal follow-ups of PIAAC have been undertaken in Poland and Germany). While longitudinal effects cannot be observed directly with the PIAAC data, Chapter 5 follows up on potential links between labour market engagement and gender differences in adult numeracy among adults of a range of ages.

The distributional patterns observed also merit further investigation. Although the finding that gender differences are larger at higher percentiles and skill levels is consistent with the existing literature, there are few studies which attempt to explain this distributional pattern with reference to broader social processes (although, see Penner 2008). Therefore, although this is a persistent phenomenon, it is poorly understood. Another priority is to explore the reasons behind large gender differences at low skill levels, which were also pronounced in some countries. These countries defy the predictions of previous literature, suggesting that there may be specific determinants of low numeracy levels among women, which are yet to be adequately understood. Gender differences at low numeracy levels are analysed throughout the rest of the thesis alongside average and high skill differences, in an attempt to shed some light on this under-explored issue.

3.7 Conclusion

This chapter has shown that, in many countries, gender differences in adult numeracy are not quantitatively large compared to other socio-demographic influences on skills. However, in some countries the difference is as large as one third of a standard deviation. Moreover, the difference is likely to be substantively significant in most countries due to its association with economic returns. Moreover, population-level average gender differences obscure complex and country-specific age group and distributional patterns which are worthy of further investigation. This chapter therefore contributes to the growing literature on gender and numeracy and its related skills, with a distinct focus on the adult population. It has highlighted that, far from being a universal phenomenon, gender differences in adult numeracy are highly variable across age groups, countries and distributions, in ways that are not fully predictable from the previous literature. The following chapters aim to address these various facets of gender differences in adult numeracy with reference to gender relations in society. Chapter 4 turns to the role of education for explaining gender differences in adult numeracy in two generations.

4. Gender and the adult numeracy skills of two generations in 21 countries: is educational exposure fundamental?

4.1 Introduction

The underlying reasons for persistent gender differences in numeracy and related skills remain the subject of much debate. Within this debate, the role of education is central. Some studies have suggested that the male advantage is associated with gender disparities in educational attainment (Baker & Jones 1993; Riegle-Crumb 2005; Pekkarinen 2012). This proposition is part of what is known as the 'gender stratification hypothesis'. A central claim of this hypothesis is that gender inequality is related to larger gender differences in numeracy skills, and, consequently, that as societies achieve gender equality by empowering women, gender differences in numeracy skills will decline. This perspective has been applied both within a comparative and a historical framework. For example, Gevrek et al.'s recent cross-country comparative study claims that 'policy initiatives aiming at bolstering female empowerment [such as through educational participation] could serve as powerful tools to improve girls' mathematics achievement' (Gevrek et al. 2018: 20). The OECD also suggests that the comparatively low numeracy skill levels of women in their 50s and 60s (evident in many countries) may be due to their fewer educational opportunities compared to both men their age and to younger women (OECD 2015). However, evidence for this perspective is inconclusive. Some research suggests that the gender gap in adolescents' mathematics achievement has been decreasing over time, as a direct result of women's increasing educational opportunities (Brody & Mills 2005; Hyde et al. 2008; Wai et al. 2010; Kane & Mertz 2012). Other comparative scholarship finds no relationship between gender differences in education and gender differences in mathematical skills (Reilly 2012; Dickerson et al. 2015). This leaves the role of education for explaining gender differences in adult numeracy somewhat unclear.

Taking the gender stratification hypothesis as a starting point, the aim of this chapter is to study the extent to which education is related to gender differences in adult numeracy. The chapter analyses how gender differences in adult numeracy among two generations (adults aged 25–34 in 2012, and adults aged 55–64 in 2012) are related to (a) the gender stratification of education levels (vertical inequalities) and (b) the gender segregation of educational fields (horizontal inequalities). First, I interrogate the assumption that gender differences in adult numeracy have been decreasing in successive generations as a result of women's increasing educational opportunities. Within this interrogation, I explicitly consider the fact that, in the majority of OECD countries, women now achieve more education than men (Buchmann et al. 2008; McDaniel 2012). How, if at all, are increasing *female advantages* in education related to the gender difference in adult numeracy? This is a key question that has so far not been well covered in the literature, which has mainly focused on the effects of historical male advantages in educational achievement and their decline.

As well as examining whether changing patterns of gender inequality in education over time are related to differences in the male numeracy advantage across the two generations, this chapter also tests an alternative educational mechanism for the gender difference in adult numeracy: gender differences in fields of study in post-compulsory education. Fields of study like science, mathematics, and engineering are more likely to equip individuals with numeracy skills than fields such as the humanities and social sciences (see Chapter 2 for evidence of this). Since marked gender differences in field of study choice continue to exist across the world (Charles & Bradley 2009; Ceci & Williams 2010; Barone 2011; Gabay-Egozi et al. 2015; Van de Werfhorst 2017), this could be a further explanation for gender differences in adult numeracy.

The broad research question addressed in this chapter is: how is education related to gender differences in adult numeracy? The more specific research questions are:

B1: To what extent do gender differences in educational attainment explain gender differences in adult numeracy? How does this vary across countries and generations?

B2: Can gender segregation of fields of study be considered a complementary mechanism sustaining gender differences in adult numeracy?

4.2 Chapter outline

The chapter begins by reviewing previous studies on the relationship between gender differences in education and gender differences in numeracy and related skills, leading to the first hypothesis. Section 4.4 discusses the potential complementary role of gender segregation of fields of study for creating gender differences in numeracy, which informs the second hypothesis. Section 4.5 explains the data and methodology. Findings are then presented in section 4.6, and the chapter concludes by discussing limitations and implications for further research, including broader reflections on the relevance of educational processes for explaining gender differences in adult numeracy.

4.3 The relationship between education and the gender difference in adult numeracy

Educational attainment is the strongest predictor of adult numeracy (Statistics Canada 2005; OECD 2013a; Bynner & Parsons 1998). This is hardly surprising, since one of the commonly agreed-upon goals of education is to instil basic skills which will be profitable to individuals in their adult lives. Numeracy skills and principles are taught across school subjects including science, mathematics, technology, and ICT, and have the potential to be included in other subjects such as geography, history and the arts. Moreover, mathematics is compulsory up to the level of upper secondary education in many countries (Hodgen et al. 2005). While there is ongoing debate regarding the direction of causation linking education and skills (Deary & Johnson 2010; Carlsson et al. 2015; Ritchie et al. 2015), there is also longitudinal evidence that education contributes to adult skills independently of prior skills or ability. For example, the contribution of education to adult cognitive skills can be empirically separated from the contribution of parental social class or pre-existing abilities developed in early childhood (Richards & Sacker 2003; Hatch et al. 2007; Clouston et al. 2012).

Compared to other skills, such as literacy, or IQ, education is particularly influential for numeracy skills. IQ, for example, is relatively stable across the life course, and is not significantly altered by educational experiences (Deary et al. 2007)[17]. In contrast, domain-specific cognitive abilities (such as numeracy) show independent associations with educational exposure (Ritchie et al. 2015). While education may influence numeracy skills directly, the association could also be mediated by reciprocal processes in adulthood. Highly educated individuals are more likely to maintain and enhance numeracy through participation in adult education and workplace training, occupational attainment, physical and social activity, and intellectually challenging leisure activity (Richards & Sacker 2003; Richards & Hatch 2011; Desjardins & Warnke 2012). Therefore, while influences on adult numeracy are multiple and varied, educational is central, particularly when comparing different age groups, who have had different levels of educational exposure (Hanushek & Zhang 2009; Schneeweis et al. 2014; Paccagnella 2016).

The expansion and equalisation of education

The later 20th and early 21st centuries witnessed a huge expansion in educational participation globally (Schofer & Meyer 2005; Baker 2014). This so-called educational revolution (Baker 2014) was accompanied by the mass entry of women into secondary, further, and higher education (Schofer & Meyer 2005; Breen et al. 2010; DiPrete & Buchmann 2013). The mass entry of women has been particularly striking in higher education. In 2012, on average, women comprised 55 per cent of tertiary

[17] While IQ is thought to be stable within individuals, secular population-level increases in IQ over the course of the 20th century *are* largely attributed to educational expansion (Pietschnig & Voracek 2015).

students in North America, Western Europe, and Central and Eastern Europe (McDaniel 2012). The OECD projected in 2008 that, by 2025, the share of women enrolled in higher education would reach 60 per cent in many of its member nations, rising to 70 per cent in the UK and Australia (Vincent-Lancrin 2008). There is a reciprocal relationship between educational expansion and gender equalisation: expansion has partly been driven by the incorporation of women (Baker & LeTendre 2005), with certain countries' rapid educational expansion fuelled by participation rates rising much more quickly among women than among men (Schofer & Meyer 2005; Shavit 2007). These trends have also meant that, in some industrialised countries, men are now more disadvantaged than women in terms of educational participation (DiPrete & Buchmann 2006; OECD 2015).

The gender stratification hypothesis

Given the important role of education for explaining patterns of cognitive skills among different generations of adults, it is also reasonable to expect that the aforementioned changes over time in the gender distribution of educational attainment may be related to gender differences in adult numeracy across generations. Specifically, women and girls' increasing exposure to education over the course of the 20th century may have contributed to an equalisation of skill levels over time. This idea has mainly been explored within the literature on adolescents' mathematical achievement. For example, Baker and Jones' 'gender stratification hypothesis' (Baker & Jones 1993) suggests that the male advantage in mathematics achievement is related to historic male advantages in education. Consequently, the male advantage in mathematics achievement is predicted to decrease as successive cohorts have been exposed to a less gender-stratified education system.

This compelling narrative has some empirical support in data from the United States (Brody & Mills 2005; Hyde et al. 2008; Wai et al. 2010; Kane & Mertz 2012). These studies show that the numeracy skills of successive generations of adolescents have equalised over time in line with the reduction of gender inequalities in education. However, studies in this area typically focus on just one age group

(15-year-olds) and use country-level indicators of gender inequality in education that relate to earlier cohorts' experiences. A welcome exception to this approach is a study by Weber et al. (2014), which explored the numeracy skills of men and women between the ages of 50 and 85 (birth cohorts 1923 to 1957), in relation to cohort-level gender inequalities in education. Weber and colleagues' central finding is that successive cohorts' increasing exposure to education has both increased all adults' skill levels *and* decreased gender differences in numeracy skills. Women who came of age in a more egalitarian education system have benefited from this in terms of their numeracy skills. The authors therefore argue that, in terms of numeracy, women benefit more than men from educational expansion and improvements in educational equity over time, so that younger cohorts of women perform better than older cohorts relative to equivalent men. This study therefore provides empirical support for the gender stratification hypothesis in relation to adults.

However, Weber et al.'s study focused only on older adults in Europe. The expansion and equalisation of education is a global phenomenon, occurring at different rates around the world (Schofer & Meyer 2005; Baker 2014). For example, in countries such as the USA and UK, the mass expansion and gender equalisation of higher education began several decades ago. Conversely, in a country like South Korea, the expansion has been much more recent (Lauder et al. 2008). Studying gender and numeracy only in the European context is limited if we wish to draw broader conclusions about the extent to which educational exposures explain gender differences in numeracy and their expression in different generations of adults. Moreover, previous studies examining gender differences in numeracy and related skills in relation to educational expansion and equalisation have not explicitly addressed the fact that, in many countries, women have not only caught up with men; women now *surpass* men in their educational attainments. This 'gender revolution' in educational participation is now a prominent topic in the sociology of education and beyond (Buchmann et al. 2008; Breen et al. 2010; Van Bavel 2012; McDaniel 2016). Despite this, it has barely been acknowledged in the literature attempting to explain the relationship between gender differences in education and gender differences in numeracy.

Using the distinct advantages of the PIAAC dataset (data from a range of countries and age cohorts; rigorous, direct measures of numeracy skills), the present chapter assesses the role of education for explaining numeracy skill differences in two generations with very different educational experiences and exposure to very different systems of education.

In relation to educational attainment, this chapter tests the following hypothesis:

> *H1: The gender difference in adult numeracy in older cohorts is explained by unequal educational attainment; due to the equalisation of educational attainment over time, the explanatory role of educational attainment is more prominent for the older cohort compared to the younger cohort and can explain the contrasting gender differences between the two cohorts.*

4.4 Field of study as a complementary mechanism?

While completing higher levels of education appears to be strongly related to adult numeracy, the quality and features of completed courses of study may also be important. Individuals emerge from further and higher study with different acquired competencies and skills (Van de Werfhorst & Kraaykamp 2001). For example, fields such as the humanities are more associated with cultural resources and social skills, while fields such as science, engineering and mathematics, are more likely to equip individuals with higher levels of numeracy skills. In expanded education systems, there is huge variation across courses and institutions in terms of the skills that individuals gain. Mathematical and numeracy-related content is particularly variable across different fields of study: for example, in the UK, it is typically poorly integrated into social science subjects in higher education (Mason et al. 2015).

Despite women's huge advances in educational participation and completion over time, numerous gender differences persist *within* education (Jacobs 1996; Bradley 2000; England 2010;; Charles 2011).

It is therefore limited to conceptualise ‘gender differences in education’ solely as differences in educational participation and attainment, as this neglects other important distinctions, such as gender differences in subjects studied (Smyth 2007). Differences in field of study are increasingly cited as an important driver of inequalities between men and women (e.g. Smyth & Steinmetz 2008; Ochsenfeld 2014). Therefore, when assessing the role of gender differences in education in producing gender differences in adult numeracy, it is important to take field of study into account, particularly given the suggestive evidence in Chapter 2 that fields of study contribute independently to adult cognitive skills.

Although there has been some improvement over time in women’s participation in STEM fields (Ramirez & Wotipka 2001), women are still more likely to study fields relating to ‘caring’ and ‘artistic’ skills: education, social science and law, the humanities and arts, and health-related fields are highly female-dominated. Men are more likely to study technical and analytical subjects (Barone 2011). The gender segregation of fields of study has remained constant even while educational expansion and female incorporation into the labour market has been rapidly increasing and is shown to channel men and women into gender-differentiated occupations (Smyth & Steinmetz 2008), which could also affect their relative ability to maintain and consolidate numeracy skills in their early labour market careers. This could be one reason that gender differences in numeracy persist between younger men and women. Female-typical, often less numerate fields of study could undergird female success in education, yet, paradoxically, equip women with less valued skillsets for the labour market (see Alon and Gelbgiser 2011).

Emerging from a complex combination of societal gender norms, perceptions of labour market opportunities (Bradley 2000), and discrimination, gender differences in fields of study can be viewed as an instance of the gendered division of labour, since the association between fields of study and careers directly reflects what is considered ‘men’s work’ and ‘women’s work’. However, the fact that the fields that men pursue often lead to higher returns (Bobbitt-Zeher 2007) suggests that this form of segregation and its expected effects on the gendered distribution of numeracy skills can also be considered a form of the gendered division of power. Hence the exclusion of women from this arena and thus from the development and maintenance of adult numeracy can be considered a form of social closure whereby women are actively excluded from status, the ability to control resources, and the capacity to manipulate information (Sells 1978). Therefore, if the female disadvantage in numeracy is associated with women's lower likelihood of studying STEM subjects, this could still suggest that women's unequal access to strategic resources in society continues to cause a gender difference in numeracy, even in contexts where women out-perform men educationally.

It should also be acknowledged that the gender segregation of fields of study, although often presented as highly consistent (Barone 2011), is variable across societies in both its nature and its implications. For example, in Eastern European countries, technical and scientific subjects are not as prestigious as elsewhere in the world, and do not give such access to status and power (Baranowska-Rataj & Unt 2012). The relative lack of prestige could mean these fields are less male-dominated and thus women have more access to numerate fields. Moreover, the pattern of men dominating numerate subjects and women dominating subjects associated with caring and social skills is more pronounced in some countries than others. For example, it is more prominent in countries with larger higher education systems (Charles & Bradley 2002, 2009). The role of the gender segregation of numerate fields of study in explaining gender differences in adult numeracy skills could therefore be highly variable across societies.

To assess the role of gender differences in field of study for explaining gender differences in adult numeracy, this chapter tests the following hypothesis, comparing its salience for two generations of adults in 20 countries:

H2: *Gender differences in adult numeracy can be partly explained by gender differences in fields of study, particularly the male domination of numerate fields.*

A note on age-period-cohort effects

The PIAAC study covers a large age range (16–65). Chapters 2 and 3 showed that there are differences in numeracy skills proficiency across age groups. In this chapter, age group differences are approached as a cohort effect. Age group differences in cognitive skills have been studied as such in other research, in the absence of longitudinal, or even directly comparable repeated cross-sectional data on adults' cognitive skills. For example, Weber et al. (2014) study older adults of different age groups in relation to cohort-level experiences of education measured at an earlier time point, while Hanushek and Zhang (2009) hypothesised that the relationship between education and skills for different age groups could be used as a cohort-level measure of the quality of education. However, it should be borne in mind that, as a cross-sectional study, without longitudinal information or repeated measures, PIAAC cannot distinguish between age, period, and cohort effects.

4.5 Methodology

The main goal of this analysis is to explain gender differences in adult numeracy, with educational attainment and fields of study as the central explanatory variables. Since the relationship between educational expansion, gender inequality in educational participation, and adult numeracy is likely to be different across countries and generations, as discussed, the chapter analyses each country separately, using linear regression models to predict average numeracy scores, and logistic regression models to predict the likelihood of adults achieving high and low numeracy skill levels.

For this chapter, the focus is on two main age groups, representing two generations who will typically have experienced very different education systems in terms of the size and inclusiveness. These are: 25–34–year-olds (born between 1978 and 1987) and 55–64-year-olds (born between 1948 and 1957). Twenty countries are included in the analysis: Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Poland, the Slovak Republic, Spain, Sweden, the United Kingdom, and the United States[18]. 'Literacy-related non-response'[19] cases are removed before analysis, but otherwise all respondents from the original PIAAC samples are included. Case numbers for each country and age group are reported in the descriptive tables in the Appendix to Chapter 4.

Dependent variable

The dependent variable in this analysis is the PIAAC numeracy score, described in detail in Chapter 2.

Independent variables

The main explanatory variable of interest in this analysis is gender, which is coded as male=1 and female=0. The other main variables of interest are *educational attainment* and *field of study.* Notwithstanding the limitations of using the ISCED classification system (outlined in Chapter 2), in this chapter, **educational attainment** is operationalised by coding three dummy variables to represent tertiary, post-secondary non-tertiary, and upper secondary education, which are compared to all levels below, which have been combined for this analysis, along with foreign qualifications. An alternative analysis using years of education is reported in Appendix A4.2 (results are very similar). Self-reported **field of study** is applicable to upper secondary and tertiary education and is derived from the nine-category ISCED Broad Fields of Education and Training (see Chapter 2). Since I am most interested in gender differences in field of study that are associated with numeracy skills, I focus on 'science and mathematics' and 'engineering', which are compared to all other fields of study using

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[18] The remaining participating countries are excluded because relevant individual-level and cohort-level data were not available.

[19] This refers to individuals whose literacy was too poor to complete the assessment or who were found to have disabilities which prevented completion, such as visual impairment – see Chapter 2.

dummy variables. A dummy variable for 'missing field' is also entered into the model and represents cases that are genuinely missing on this variable rather than not having the required level of education to report their field of study. Descriptive statistics for both education variables in both age groups can be found in Appendices A4.3-A4.6.

Control variables

Control variables at the individual level are **immigrant status** (first or second generation immigrant vs. all others) and **parents' education level** (at least one parent tertiary vs. both parents below tertiary).

Analytical strategy

To highlight the contrast between the age groups in terms of both gender differences in educational attainment and gender differences in adult numeracy, I first present some descriptive scatter plots. These plots can be used both to compare age groups within a country (by comparing across the two panels of the plot) or to compare countries within an age group. Further guidance in interpreting these plots is given at the beginning of the results section.

The role of individual-level educational attainment and field of study for explaining gender differences in adult numeracy is then assessed using a series of country-specific regression models, estimated separately by age group.

Equation 1 below is used to calculate the 'raw' gender difference in mean numeracy score with no covariates and is equivalent to subtracting the female mean score from the male mean score. Equation 2 represents the situation where I add control variables, X_k, in this case, individuals' immigration background and parental education (social-demographic characteristics, labelled 'socdem'). In Equation 3, I add individuals' educational attainment, and, in Equation 4, their field of study (labelled FOS). The gender coefficient β_1 from Equation 4 then represents the male advantage in numeracy when controlling for individuals' social-demographic characteristics, years of education and field of study. The gender coefficients from Equations 3 and 4 can be compared to the coefficients from the previous step, to assess how much of the initial gender difference was 'explained'. The logistic models predicting individuals' likelihood of reaching high and low numeracy levels (the PIAAC international benchmarks) proceed in a similar fashion; for more detail on the specification of these models, refer to Chapter 2.

(1) $y_i = \beta_0 + \beta_1 \, male_i + \varepsilon_i$

(2) $y_i = \beta_0 + \beta_1 \, male_i + \beta_k \, socdem_i + \varepsilon_i$

(3) $y_i = \beta_0 + \beta_1 \, male_i + \beta_k \, socdem_i + \beta_k \, education_i + \varepsilon_i$

(4) $y_i = \beta_0 + \beta_1 \, male_i + \beta_k \, socdem_i + \beta_k \, education_i + \beta_k \, FOS_i + \varepsilon_i$

The statistical significance of any changes in the gender coefficient across the models is estimated using the post-estimation methods described in Chapter 2.

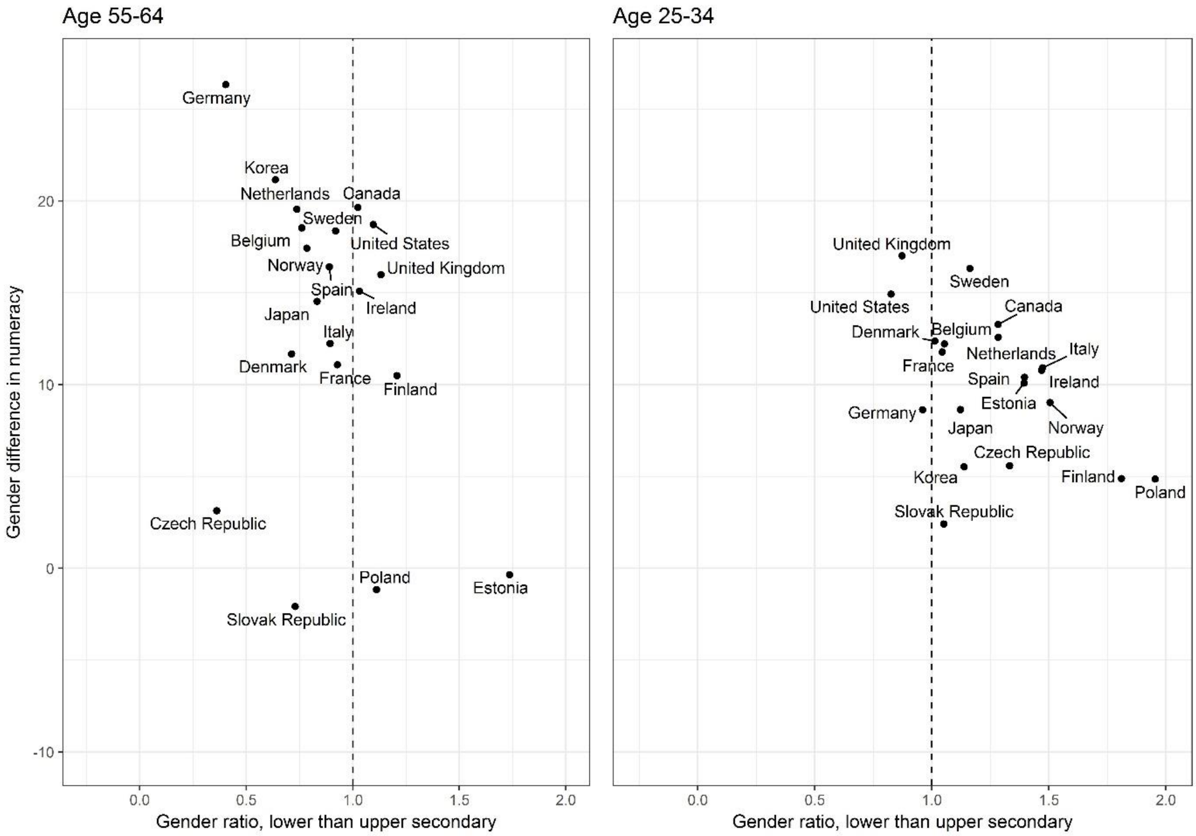
4.6 Results

To highlight the contrast between the age groups in terms of both gender differences in educational attainment and gender differences in adult numeracy, Figure 4.1 shows the gender ratio (male to female) with below upper secondary qualifications for the two age groups, on the x axis. A ratio above 1 indicates that the level of education is male-dominated, while a ratio below 1 indicates that it is female-dominated. The figure also shows, for each country and age group, the gender difference in adult numeracy, on the y axis. This enables us to evaluate the extent to which gender differences in educational opportunities in the two age groups are related to gender differences in adult numeracy.

Figure 4.1 demonstrates that in the older cohort, women have completed lower levels of education than men, whereas for several countries in the younger age group (particularly Finland, Poland, Norway, Ireland, Italy, Spain, and Estonia), more men than women have low levels of education, shown by the majority of gender ratios being above 1. In other countries (Germany, Japan, Korea, Denmark), low education is around gender parity in the younger age group , shown by the fact that the gender ratio is around 1The contrast between the two panels of the graph reflect the fact that gender inequalities in education have narrowed over time, and in many cases, among younger adults, the lowest educated in society tend to be men (e.g. Buchmann et al. 2008). However, education has expanded and equalised at different rates in different societies (Hannum & Buchmann 2003; Schofer & Meyer 2005; Breen et al. 2010). This is also demonstrated by the wide variation in gender ratios in both age groups, which reflect the historical timing and pace of change regarding female incorporation into upper secondary education and beyond. For example, this happened earlier in the Nordic countries, the United States and Canada (gender ratios are close to 1 in the first panel of the graph) and occurred much more recently in the Czech Republic, Germany, and Korea, shown by the fact that older women in these countries are much more likely to have low levels of education than women in other countries.

The pattern in the graph also suggests that, as women have become better educated, gender differences in adult numeracy have declined. In around half the countries (the clearest examples being Germany, Korea, and the Netherlands) in the older age group, more women than men have low levels of education. In these counties/age groups, we also see large gender differences in numeracy. For example, German women aged 55–64 in 2012 were, on average around twice as likely as men to have low levels of education, and their numeracy skills are on average 26 points lower. As women have become more integrated into education, in the younger cohort, gender differences in adult numeracy are smaller in Germany – around nine points difference between men and women's average scores. We see this contrast particularly in Germany, Japan, and Korea. This confirms the predictions of the gender stratification hypothesis for these countries: as women have advanced their educational participation over time, the gender difference in numeracy has also become smaller. However, there are exceptions to this trend. In some countries, although women have become better educated relative to men, the gender difference in numeracy is at a similar level in younger and older age groups (for example, compare the position of the two age group data points in Denmark and Sweden). This shows that, in the younger age group, although men on average have lower levels of education than women, they still have an advantage in numeracy. In other countries, notwithstanding women's improved educational position, the gender difference is actually larger in the younger than the older cohort (the Czech Republic, the Slovak Republic, and Poland).

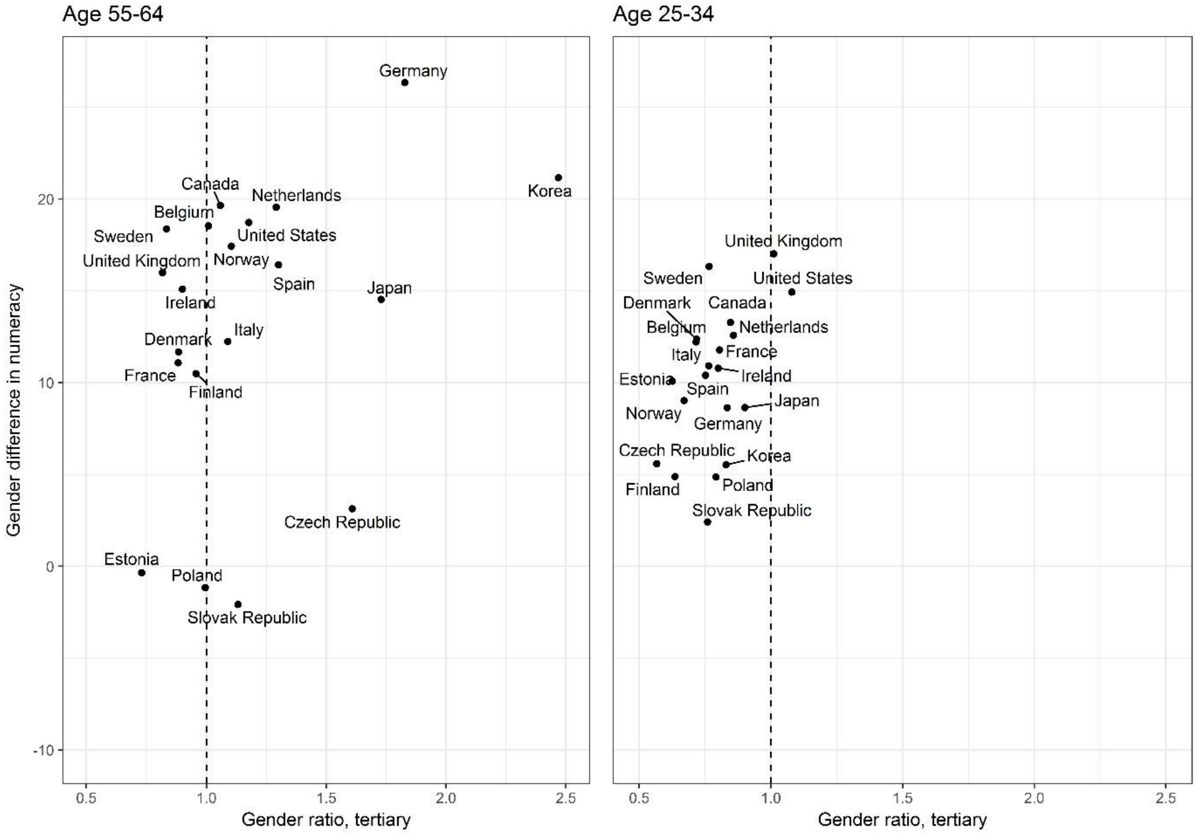
Figure 4.1 Gender ratio (male to female), below upper secondary qualifications, and gender difference in adult numeracy, 20 OECD countries



Source: Author's calculations using PIAAC dataset. PIAAC sampling and replicate weights applied. Full descriptive statistics on educational attainment by gender and age group can be found in the Appendix to Chapter 4.

Turning to tertiary qualifications, Figure 4.2 shows the male to female ratio holding tertiary qualifications in the two age groups (on the x axis), in relation to the gender difference in adult numeracy (on the y axis). The chart shows an increase in female participation in higher education across the two age groups (shown by the fact that, in the younger age group, men are under-represented among adults with tertiary qualifications, whereas in the older age group, men are either over-represented or equally represented). Again, there is wide variation in gender ratios in the older age group: in the Nordic countries, the UK and Ireland, tertiary qualifications are evenly distributed between men and women; while in Germany, Japan, Korea, and the Czech Republic they are strongly male-dominated. In the case of Germany, this is likely to reflect more modest higher educational expansion than in other countries (Powell & Solga 2011), while Korea has experienced recent, rapid expansion (Lauder et al. 2008). In some cases, the increased representation of women among university-educated adults, in the younger age group, is seen alongside a reduced gender difference in numeracy (Finland, Norway, Germany, the Netherlands, Spain, Italy, and Korea, for example), providing support for the gender stratification hypothesis. However, in other countries, such as France, Denmark, and the UK, the gender difference in both educational qualifications and in adult numeracy are similar in the two age groups. In the younger age group, there is much less variation between countries in the gender ratio, yet substantial variation in the gender difference in adult numeracy. This suggests that the increasing move of women into higher education has not been universally accompanied by a reduction in the gender difference in adult numeracy, and that substantial gender differences in adult numeracy remain even in contexts where women predominate among university-educated adults. Therefore, based on this figure, support for the gender stratification hypothesis is mixed, depending very much on the country considered. However, figures 4.1 and 4.2 show only raw, average differences in adult numeracy. To fully understand how gender differences relates to education in different age groups, we need to account for educational attainment at the individual level, as well as controlling for other factors at the individual level that influence adult numeracy and examining gender differences at distribution extremes.

Figure 4.2 Gender ratio, tertiary qualifications, and gender difference in adult numeracy, 20 OECD countries



Source: Author's calculations using PIAAC dataset. PIAAC sampling and replicate weights applied. Full descriptive statistics on educational attainment by gender and age group can be found in the Appendix to Chapter 4.

Does gender inequality in educational attainment explain gender differences in adult numeracy?

Table 4.1 shows the gender coefficients from two sequential regression models predicting average levels of adult numeracy, for 25–34-year-olds and 55–64-year-olds. Model 2 controls for socio-demographic factors only (immigrant status, parental education). Model 3 adds educational attainment.

Among 55–64-year-olds, the gender difference in adult numeracy either stays the same or reduces when adding educational attainment into the model. Where the reduction is significant (highlighted in bold), this suggests that differences in educational qualifications between men and women *can* partly explain the gender difference in adult numeracy. This is the case for 11 of the countries in the analysis. This is particularly the case in countries where education is most unequal in this age group, as shown in figures 4.1 and 4.2 – in Germany and Korea, the gender coefficient decreases by around ten points in Model 3. Thus, for the older age group, the hypothesis that gender difference in adult numeracy can be partly explained by gender difference in educational attainment is supported for these countries' data. However, in other countries (for example, France, Finland, Norway, Sweden), gender differences do not change when controlling for educational attainment.

In the younger age group, 25–34-year-olds, gender differences <u>increase</u> when controlling for educational attainment. This increase in the gender coefficient in Model 3 is, in most cases, substantial and statistically significant. The increase is largest in countries where tertiary educational qualifications are most strongly female-dominated – Finland, Norway, Estonia, and the Czech Republic, for example. The results suggest that when comparing young men and women with the same educational level, there is an even larger gender difference in numeracy than previously seen without controlling for education. However, in Germany and Japan, there is no increase in the gender coefficient, while in the Slovak Republic, the gender difference remains non-significant regardless of control variables.

Table 4.1 Gender coefficients from OLS regression predicting adult numeracy in two age groups, Models 2 and 3

	25–34-year-olds				55–64-year-olds			
	Model 2		Model 3		Model 2		Model 3	
Country	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Belgium	9.91***	3.35	**16.91*****	**3.14**	19.42***	3.59	**16.83*****	**3.36**
Canada	12.81***	2.63	**16.63*****	**2.59**	19.59***	2.59	**18.94*****	**2.48**
Czech Republic	5.58	3.98	**12.79*****	**3.6**	2.8	4.35	**-4.51**	**4**
Denmark	16.85***	3.25	**20.58*****	**3.16**	13.61***	2.14	**12.88*****	**2.03**
Estonia	9.16**	3.06	**15.97*****	**2.92**	-0.71	2.27	**4.37**	**2.26**
Finland	6.42**	3.01	**12.69*****	**2.94**	10.17***	3.14	11.74***	3.01
France	8.86**	2.71	**13.85*****	**2.31**	12.74***	2.82	11.87***	2.76
Germany	7.19**	3.24	8.9	3.31	26.09***	3.93	**17.51*****	**3.75**
Ireland	11.44***	3.37	**15.43*****	**3.21**	14.01***	4.33	15.55***	4.03
Italy	11.34***	4.37	**16.20*****	**4**	12.45***	3.97	**9.09****	**3.68**
Japan	9.79***	3.01	10.74***	2.84	14.01***	3.32	9.34**	3.14
Korea	4.93*	2.23	**7.64****	**2.27**	21.43***	3.16	**9.81*****	**2.83**
Netherlands	10.75***	3.53	**15.00*****	**3.04**	18.94***	3.16	**13.20*****	**2.78**
Norway	12.14***	3.03	**18.76*****	**2.87**	16.98***	3.57	15.58***	3.21
Poland	4.93	3.1	**9.98*****	**3.09**	3.23	3.59	4.48	3.57
Slovak Republic	0.95	2.99	4.18	2.75	-2.55	2.9	-6.42*	2.75
Spain	8.42**	2.8	**14.11*****	**2.75**	17.37***	3.18	**14.00*****	**2.84**
Sweden	12.17***	3.48	**17.58*****	**3.35**	16.77***	3.02	16.82***	2.94
UK	14.03***	3.8	13.18***	3.45	19.37***	3.48	**16.62*****	**3.6**
USA	13.59***	3.49	**19.41*****	**2.86**	18.61***	4.01	17.11***	3.72

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. $p < 0.05$, * $p < 0.01$, ** $p < 0.001$,*** . Model 2 regresses adult numeracy on gender, immigrant status, parental education. Model 3 = Model 2 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below). Coefficients that represent a statistically significant change from the previous model are highlighted in bold and grey.

Tables 4.2 and 4.3 show the results from equivalent models which explore how gender influences the likelihood of achieving high levels of adult numeracy (Table 4.2) and low levels of adult numeracy (Table 4.3). Results were fairly similar to the results in Table 4.1, in that the odds ratio of males achieving high levels of numeracy *increased* in Model 3 in the younger age group, while the likelihood of men achieving low levels of numeracy *decreased*. There was some evidence that unequal educational attainment could explain men's disproportionate likelihood of reaching high levels of numeracy, particularly in the older age group in Japan, Korea, and the Netherlands, where the odds ratios decreased significantly from their initial level. However, in most cases, men were still at least twice as likely to achieve high levels of adult numeracy as women, even when controlling for educational attainment. Similar results were seen for low skill levels in Korea and the Netherlands. Among younger adults, male advantage at high skill levels increased when controlling for education in Belgium, Canada, Estonia, Finland, Norway, Poland, and Spain. Overall, except in the countries noted, educational attainment does not appear to be a powerful explanatory factor explaining male advantage at distribution extremes. Moreover, accounting for educational attainment significantly exacerbates gender differences in numeracy among the younger age group in several countries.

Table 4.2 Odds ratio (male) from logistic regression predicting high numeracy level in two age groups, Models 2 and 3

	25–34-year-olds				55–64-year-olds			
	Model 2		Model 3		Model 2		Model 3	
Country	**OR**	**SE**	**OR**	**SE**	**OR**	**SE**	**Coef**	**SE**
Belgium	1.54***	0.24	**2.44*** **	**0.46**	2.49***	0.51	2.45***	0.53
Canada	1.63***	0.19	**1.97*** **	**0.25**	2.26***	0.25	2.34***	0.28
Czech Republic	1.65***	0.28	2.80***	0.56	1.54***	0.44	1.17***	0.38
Denmark	2.07***	0.31	2.68***	0.43	2.14***	0.24	2.41***	0.28
Estonia	1.41***	0.19	**1.93*** **	**0.27**	1.16***	0.16	**1.49*** **	**0.21**
Finland	1.40***	0.18	**1.92*** **	**0.29**	2.03***	0.28	2.29***	0.31
France	1.43***	0.17	2.05***	0.25	2.21***	0.34	2.62***	0.48
Germany	1.28***	0.16	1.51***	0.24	2.50***	0.43	2.31***	0.43
Ireland	2.08***	0.30	2.56***	0.42	3.83***	1.02	4.83***	1.33
Italy	2.19***	0.43	2.83***	0.56	2.53***	0.98	2.37***	0.90
Japan	1.49***	0.20	1.58***	0.22	2.55***	0.41	**2.25*** **	**0.38**
Korea	1.55***	0.21	1.77***	0.26	3.60***	1.25	**1.91*** **	**0.69**
Netherlands	1.74***	0.25	2.25***	0.31	3.18***	0.52	**2.86*** **	**0.49**
Norway	1.75***	0.25	**2.56*** **	**0.44**	2.35***	0.46	2.42***	0.49
Poland	1.38***	0.19	**1.64*** **	**0.26**	1.00	0.24	0.97	0.23
Slovak Republic	1.15	0.17	1.38***	0.21	1.19	0.19	1.06	0.17
Spain	1.69***	0.29	**2.26*** **	**0.41**	4.31***	1.81	3.97***	1.78
Sweden	1.82***	0.25	2.46***	0.39	2.07***	0.33	2.38***	0.45
UK	1.45***	0.23	1.47***	0.24	1.85***	0.31	1.77***	0.33
USA	1.99***	0.34	2.66***	0.46	2.04***	0.33	2.01***	0.35

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,*** Model 2 regresses adult numeracy on gender, immigrant status, parental education. Model 3 = Model 2 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below). Odds ratios which represent a statistically significant change from the previous models are highlighted in grey (estimated using KHB method). 'High numeracy skills' =scores above 304 points. Odds ratios that represent a statistically significant change from the previous model are highlighted in bold (estimated using the KHB method across ten plausible values).

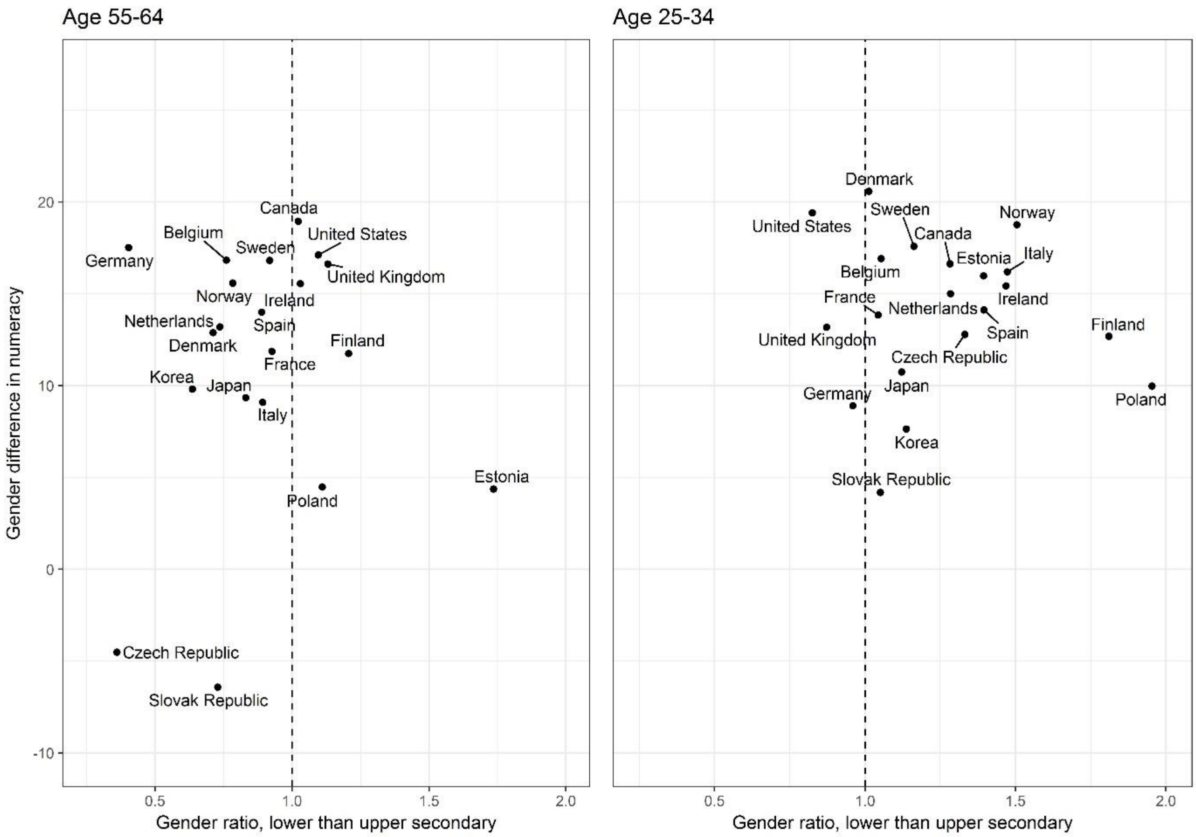
Table 4.3 Odds ratio (male) from logistic regression predicting low numeracy level in two age groups, Models 2 and 3

	25–34-year-olds				55–64-year-olds			
	Model 2		Model 3		Model 2		Model 3	
Country	OR	SE	OR	SE	OR	SE	Coef	SE
Belgium	0.74***	0.18	**0.52***	**0.14**	0.52***	0.07	0.53***	0.08
Canada	0.79***	0.09	0.67***	0.09	0.53***	0.04	0.49***	0.05
Czech Republic	0.58***	0.13	0.45***	0.11	1.07	0.21	1.56***	0.32
Denmark	0.83***	0.17	0.74***	0.17	0.67***	0.07	0.71***	0.08
Estonia	0.64***	0.11	**0.42***	**0.08**	1.10	0.13	**0.90**	**0.11**
Finland	1.30***	0.31	1.04	0.25	0.78***	0.09	0.72***	0.09
France	0.91*	0.13	0.73***	0.11	0.71***	0.07	0.70***	0.07
Germany	0.64***	0.13	0.55***	0.14	0.44***	0.07	0.55***	0.10
Ireland	0.77***	0.11	0.62***	0.09	0.50***	0.07	0.44***	0.06
Italy	0.76***	0.14	0.61***	0.12	0.73***	0.11	0.80***	0.13
Japan	0.93**	0.19	0.89***	0.19	0.78***	0.13	**0.88***	**0.16**
Korea	0.91**	0.16	**0.77***	**0.15**	0.48***	0.06	**0.70***	**0.10**
Netherlands	0.87***	0.22	**0.69***	**0.18**	0.51***	0.07	**0.60***	**0.09**
Norway	0.66***	0.14	**0.45***	**0.12**	0.60***	0.10	0.61***	0.09
Poland	0.91***	0.14	**0.74***	**0.12**	0.84***	0.13	0.79***	0.14
Slovak Republic	1.16**	0.18	1.04	0.19	1.09	0.13	1.29***	0.17
Spain	0.85***	0.11	**0.63***	**0.10**	0.50***	0.07	0.51***	0.08
Sweden	0.95**	0.25	0.70***	0.20	0.57***	0.09	0.53***	0.10
UK	0.56***	0.10	0.53***	0.10	0.57***	0.08	0.60***	0.10
USA	0.77***	0.10	0.58***	0.08	0.69***	0.09	0.69***	0.10

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,*** Model 2 regresses adult numeracy on gender, immigrant status, parental education. Model 3 = Model 2 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below). Odds ratios which represent a statistically significant change from the previous models are highlighted in grey (estimated using KHB method). 'Low numeracy skills' =scores below 238 points. Odds ratios that represent a statistically significant change from the previous model are highlighted in bold (estimated using the KHB method across ten plausible values).

Figure 4.3 shows that the contrast between the two age groups, previously seen in Figure 4.1, disappears once we control for individual educational attainment. This suggests that the contrast between the two age groups, in terms of the gender difference in adult numeracy, was largely a function of contrasting patterns of gender and educational attainment. However, it should also be noted that in most countries, once we control for education, gender differences in adult numeracy have by no means disappeared – instead, they converge between 10 and 20 points in both age groups. This suggests that although the contrast between the generations is related to the decline in educational inequalities over time, educational differences between men and women *within* each generation still cannot fully explain the gender difference in adult numeracy. The exception to this is Germany, Korea, and Japan, where we see that gender differences in the adult age group are much reduced from what we saw in Figure 4.1, when controlling for education level. The post-Soviet countries are still clear outliers in the older age group.

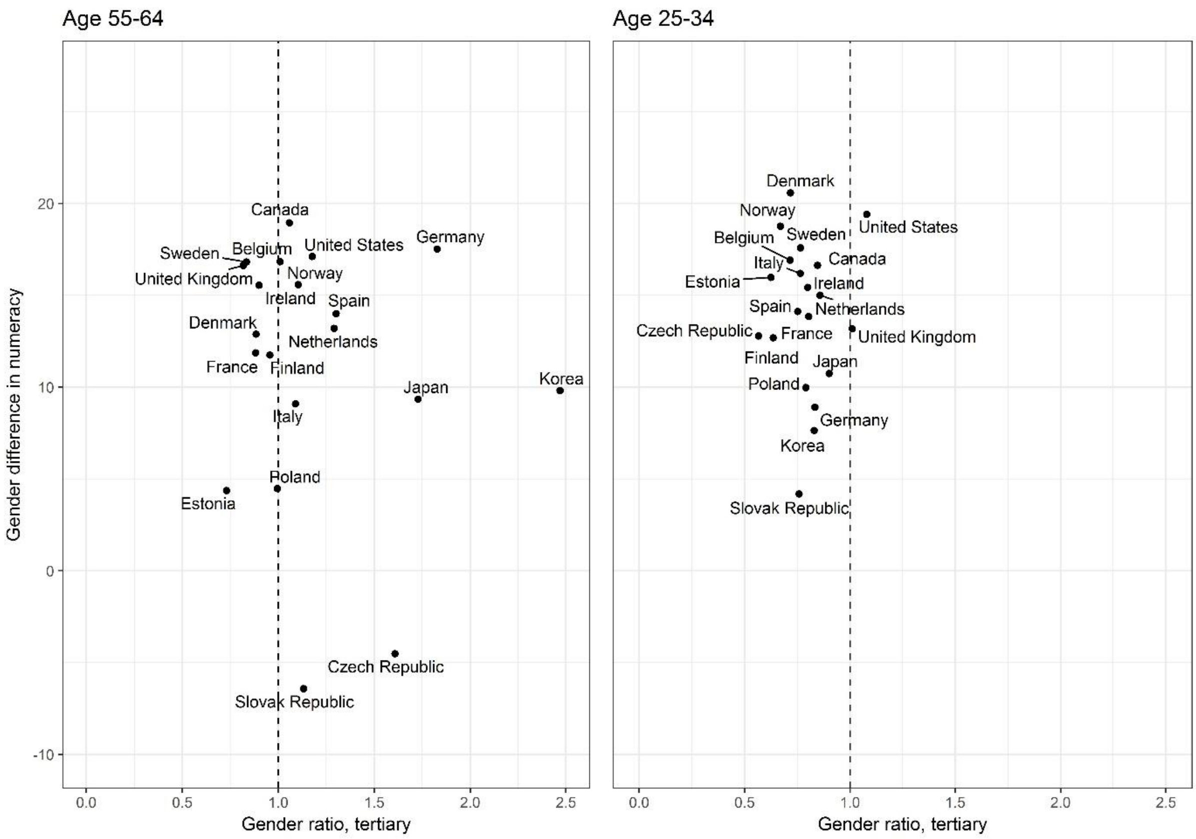
Figure 4.3 Gender ratio, below upper secondary qualifications, and gender difference in adult numeracy controlling for educational attainment, 20 OECD countries



Source: Author's calculations using PIAAC dataset. PIAAC sampling and replicate weights applied.

Figure 4.4 shows that the gradient we previously saw in Figure 4.2, once again disappears once we control for individual educational attainment. Now, it seems that the female advantage in tertiary qualifications in the younger age group is associated with a larger male advantage in adult numeracy in the younger than the older age group(see Denmark, Norway, Belgium, Estonia). This is largely a function of the fact that individual-level differences in education reduced the gender difference in the older age group, whereas it increased in the age group. Overall, Figure 4.4 suggests that, although changes in the gender distribution of tertiary qualifications can partly explain the contrast between age groups in the gender difference in adult numeracy, female advantages in tertiary qualifications are often associated with larger, unexplained gender differences in adult numeracy. Moreover, gender inequality in educational attainment does not always occur alongside large gender differences in adult numeracy. This is particularly the case in the Czech and Slovak Republics, where women in the older age group have slightly better numeracy skills than men, despite being disadvantaged educationally. This illustrates effectively that gender inequality in education does not necessary lead to larger gender differences in adult numeracy, and vice versa.

Figure 4.4 Gender ratio, tertiary qualifications, and gender difference in adult numeracy controlling for educational attainment, 20 OECD countries



Source: Author's calculations using PIAAC dataset. PIAAC sampling and replicate weights applied.

Is field of study a complementary mechanism?

This chapter also set out to test whether field of study could be considered a complimentary mechanism sustaining gender differences in adult numeracy in the two generations. This was tested by adding the field of study dummy variables (engineering, mathematics and science) in a fourth model, building on Model 2.

In most cases, field of study could not explain the remaining gender differences in adult numeracy (Table 4.4). However, in the younger age group, it appeared to reduce the gender difference in Japan, Italy and Canada (Table 4.4), and Ireland (tables 4.5 and 4.6) and in the older cohort in Japan (Table 4.4). This suggests that in these countries and age groups, the gender difference in adult numeracy is accounted for to some extent by the tendency for men to study numerate subjects more often than women. However, although the male domination of numerate fields of study is a widespread phenomenon, it does not provide a systematic explanation of gender differences in adult numeracy across all countries.

Table 4.4 Gender coefficients from OLS regression predicting adult numeracy in two age groups, Models 3 and 4

	25–34-year-olds				55–64-year-olds			
	Model 3		Model 4		Model 3		Model 4	
Country	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Belgium	16.91***	3.14	16.14***	3.21	16.83***	3.36	**17.41*****	**3.46**
Canada	16.63***	2.59	**13.75*****	**2.8**	18.94***	2.48	17.01***	2.61
Czech Republic	12.79***	3.6	12.17***	4.54	-4.51	4	-4.2	4.9
Denmark	20.58***	3.16	19.67***	3.27	12.88***	2.03	13.11***	2.19
Estonia	15.97***	2.92	17.85***	3.02	4.37	2.26	2.85	2.37
Finland	12.69***	2.94	12.48***	3.32	11.74***	3.01	8.69***	3.47
France	13.85***	2.31	12.90***	2.34	11.87***	2.76	10.63***	2.91
Germany	8.9	3.31	12.11***	3.61	17.51***	3.75	20.32***	4.42
Ireland	15.43***	3.21	13.30***	3.07	15.55***	4.03	14.05***	4.27
Italy	16.20***	4	**14.11*****	**4.19**	9.09**	3.68	7.95**	3.82
Japan	10.74***	2.84	**7.37****	**3.18**	9.34**	3.14	**5.41****	**3.24**
Korea	7.64**	2.27	7.94**	2.52	9.81***	2.83	9.78***	2.8
Netherlands	15.00***	3.04	12.01***	3.2	13.20***	2.78	9.91***	3.04
Norway	18.76***	2.87	16.71***	2.88	15.58***	3.21	16.14***	3.58
Poland	9.98***	3.09	8.59***	3.33	4.48	3.57	0.62	3.75
Slovak Republic	4.18	2.75	2.55	2.76	-6.42*	2.75	-7.15*	3.09
Spain	14.11***	2.75	12.41***	2.85	14.00***	2.84	13.65***	3.02
Sweden	17.58***	3.35	16.60***	3.69	16.82***	2.94	15.49***	3.33
UK	13.18***	3.45	12.03***	3.61	16.62***	3.6	15.01***	3.72
USA	19.41***	2.86	16.78***	3.05	17.11***	3.72	14.65***	3.59

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,*** . Model 3 = Model 2 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below).Model 4 = Model 3 + field of study (science + mathematics; engineering and a missing field dummy, compared to all other fields). Coefficients which represent a statistically significant change from the previous models are highlighted in grey. Coefficients that represent a statistically significant change from the previous model are highlighted in bold.

Table 4.5 Odds ratio (male) from logistic regression predicting high numeracy skills in two age groups, Models 3 and 4

	25–24-year-olds				55–64-year-olds			
	Model 3		**Model 4**		**Model 3**		**Model 4**	
Country	**OR**	**SE**	**OR**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Belgium	2.44***	0.46	2.32***	0.46	2.45***	0.53	2.50***	0.55
Canada	1.97***	0.25	1.76***	0.23	2.34***	0.28	2.14***	0.29
Czech Republic	2.80***	0.56	2.77***	0.57	1.17***	0.38	1.34***	0.48
Denmark	2.68***	0.43	2.57***	0.46	2.41***	0.28	2.36***	0.29
Estonia	1.93***	0.27	2.15***	0.33	1.49***	0.21	1.33***	0.19
Finland	1.92***	0.29	1.75***	0.29	2.29***	0.31	2.08***	0.32
France	2.05***	0.25	1.87***	0.23	2.62***	0.48	2.37***	0.41
Germany	1.51***	0.24	1.64***	0.30	2.31***	0.43	2.47***	0.48
Ireland	2.56***	0.42	**2.21*** **	**0.36**	4.83***	1.33	4.99***	1.43
Italy	2.83***	0.56	2.62***	0.57	2.37***	0.90	2.34***	0.81
Japan	1.58***	0.22	1.30**	0.21	2.25***	0.38	**1.91*** **	**0.37**
Korea	1.77***	0.26	1.78***	0.29	1.91***	0.69	1.87***	0.69
Netherlands	2.25***	0.31	2.09***	0.33	2.86***	0.49	2.47***	0.48
Norway	2.56***	0.44	2.45***	0.43	2.42***	0.49	2.44***	0.54
Poland	1.64***	0.26	1.59***	0.27	0.97	0.23	**0.57* **	**0.16**
Slovak Republic	1.38***	0.21	1.13	0.20	1.06	0.17	1.09	0.20
Spain	2.26***	0.41	1.77***	0.33	3.97***	1.78	3.16***	1.65
Sweden	2.46***	0.39	2.44***	0.41	2.38***	0.45	2.12***	0.43
UK	1.47***	0.24	1.44***	0.26	1.77***	0.33	1.72***	0.33
USA	2.66***	0.46	2.17***	0.42	2.01***	0.35	1.87***	0.37

Note: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,*** Model 2 = Model 1 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below). Model 3 = Model 2 + field of study (science + mathematics; engineering and a missing field dummy, compared to all other fields). Odds ratios which represent a statistically significant change from the previous models are highlighted in grey (estimated using KHB method). Full model results are given in Appendix to Chapter 4. ‘High numeracy skills’ = scores above 304 points.

Table 4.6 Odds ratio (male) from logistic regression predicting low numeracy skills in two age groups, Models 3 and 4

	25–34-year-olds				55–64-year-olds			
	Model 3		Model 4		Model 3		Model 4	
Country	**OR**	**SE**	**OR**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Belgium	0.52***	0.14	0.47***	0.14	0.53***	0.08	0.52***	0.09
Canada	0.67***	0.09	0.71***	0.10	0.49***	0.05	0.55***	0.05
Czech Republic	0.45***	0.11	0.41***	0.14	1.56***	0.32	1.66***	0.40
Denmark	0.74***	0.17	0.66***	0.17	0.71***	0.08	0.68***	0.09
Estonia	0.42***	0.08	0.39***	0.08	0.90	0.11	0.95	0.12
Finland	1.04	0.25	0.95***	0.25	0.72***	0.09	0.82***	0.12
France	0.73***	0.11	0.67***	0.11	0.70***	0.07	0.74***	0.08
Germany	0.55***	0.14	0.61***	0.16	0.55***	0.10	0.44***	0.09
Ireland	0.62***	0.09	**0.69*** **	**0.10**	0.44***	0.06	0.47***	0.07
Italy	0.61***	0.12	0.65***	0.14	0.80***	0.13	0.87***	0.14
Japan	0.89***	0.19	1.09**	0.26	0.88***	0.16	0.98	0.18
Korea	0.77***	0.15	0.78***	0.17	0.70***	0.10	0.69***	0.10
Netherlands	0.69***	0.18	0.67***	0.19	0.60***	0.09	0.65***	0.10
Norway	0.45***	0.12	0.59***	0.16	0.61***	0.09	0.64***	0.12
Poland	0.74***	0.12	0.79***	0.14	0.79***	0.14	0.83***	0.15
Slovak Republic	1.04	0.19	1.02	0.21	1.29***	0.17	1.31***	0.23
Spain	0.63***	0.10	0.64***	0.11	0.51***	0.08	0.51***	0.08
Sweden	0.70***	0.20	0.76***	0.22	0.53***	0.10	0.53***	0.10
UK	0.53***	0.10	0.53***	0.10	0.60***	0.10	0.69***	0.12
USA	0.58***	0.08	0.61***	0.09	0.69***	0.10	0.77***	0.11

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,*** Model 3 = Model 2 + educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below). Model 4 = Model 3 + field of study (science + mathematics; engineering and a missing field dummy, compared to all other fields). Odds ratios which represent a statistically significant change from the previous models are highlighted in grey (estimated using KHB method). Full model results are given in the Appendix to Chapter 4. 'Low numeracy skills' =scores below 238 points.

4.7 Discussion

Despite much research on the topic of gender, numeracy, and related skills, it is still unclear what explains the male advantage, which is remarkably persistent, while being highly variable across different societies. A frequent proposition is that gender differences in numeracy skills are explained by gender inequality in educational attainments. Given the massive expansion and equalisation of education over recent decades, this implies that gender differences in numeracy will have decreased over time, as education has become more gender-equal, and thus will be smaller among younger generations. The aim of this chapter was test to what extent this hypothesis applies to two generations of adults in OECD countries. Specifically, it evaluated the relationship between gender differences in adult numeracy and (a) the gender stratification of education levels (vertical inequalities) and (b) the gender segregation of educational fields (horizontal inequalities). The analysis focused on the individual level, attempting to establish how much of the gender gap in numeracy can be 'explained' by gender differences in educational exposure and experiences.

The most important finding of this chapter is that the gender stratification hypothesis, which predicts a relationship between gender inequality in education and gender differences in numeracy, is only partially supported among adults in contemporary, industrialised nations. Although it seems that declining educational inequality may be partly responsible for the contrast in gender differences between older and younger adults, the explanatory role of education *within* generations is less clear. Among older adults (aged 55–64) in the Netherlands, Germany, Korea, and Japan, gender differences in adult numeracy could be partly explained by gender differences in educational attainment. However, in other countries, such as Finland, Norway, and Sweden, educational attainment had no explanatory power. This is likely to be because education was highly gender-stratified among older adults in the former countries, whereas participation was already equalised in the latter countries several decades ago. Yet gender differences in numeracy remain in those 'equalised' countries. Therefore, while it may seem straightforward that gender inequalities in education are responsible for gender differences in numeracy, particularly among older adults, and this is supported by the evidence from selected countries, this is not universally the case. While the gender stratification hypothesis partly explains the difference between generations in the size of the gender difference, the equalisation of educational participation has not necessarily led to a reduction in the gender difference in adult numeracy, particularly when it comes to tertiary qualifications. These results raise the important question of why gender differences in numeracy remain in countries that have had parity in educational participation for a long time, and what other mechanisms are sustaining these differences.

Among younger adults in most countries, gender differences in numeracy *increased* when controlling for educational attainment. This suggests that highly qualified men have better numeracy skills than highly qualified women. The fact that more men than women study numerate fields in further education partly explains this, although its role is not systematic across countries. The chapter therefore found some support for Hypothesis H2, but it was not consistent. There was therefore limited evidence that field of study is a systematic, complimentary mechanism sustaining gender differences in numeracy skills. The explanatory role of field of study was evident in Japan, with some evidence that it may be important in other countries such as Canada, Belgium, and Italy. This suggests that getting more women into science, mathematics and engineering programmes in further and higher education may be an effective strategy to reduce gender differences in adult numeracy. Fields of study may also be connected to adult numeracy through other mechanisms, such as the occupations individuals go on to pursue after graduation. Whether gender differences in occupations can explain gender differences in adult numeracy is explored further in Chapter 5.

The lack of a systematic role of field of study for explaining gender differences in adult numeracy could be because both the nature and implications of gender segregation of fields of study varies across societies. The introduction suggested that the gender difference in numeracy could be connected to widespread male domination of the powerful and strategic resources, or the gender division of power, indexed by male domination of numerate fields of study. Yet, it must be noted that connection between male power, science, and numeracy is not necessarily universal. For example, in Eastern European countries, technical and scientific subjects are not as prestigious as elsewhere, nor are they as male-dominated (Baranowska-Rataj & Unt 2012). This could be one reason that the gender difference in numeracy is less pronounced in these countries. Moreover, gender-differentiated fields of study do not necessarily map directly onto the gendered division of roles within the labour market (Smyth & Steinmetz 2008). This could dampen the association between field of study and adult numeracy.

The chapter makes several contributions to the literature on gender differences in numeracy and related skills. Firstly, it problematises and re-evaluates the conceptualisation and measurement of 'gender inequality in education', showing that this is highly country- and cohort-specific, and adding in horizontal segregation. Secondly, it has contributed new evidence which suggests that the claims of the gender stratification hypothesis regarding education may simply be outdated when one considers the vast changes in education over recent decades in this set of countries. This is interesting in light of claims that cognitive skills of successive generations of women have benefitted greatly from improvements in educational exposure (Weber et al. 2014). This chapter finds evidence contrary to this assertion, given that when comparing younger adults with similar levels of education (Model 2), men's advantage in numeracy is still significant in most countries. These results are important because they run contrary to the narrative, prevalent in much research in this area (e.g. Baker & Jones 1993; Weber et al. 2014), that gender differences in numeracy and related skills will somehow naturally decline as women are more exposed to greater educational opportunity. The findings instead support the results of recent studies which suggest that the effects of educational exposure for men and women's outcomes could be unexpected or contradictory, due to men and women deriving different benefits from educational exposures, or due to inequalities within educational institutions (e.g. Alon & Gelbgiser 2011; Dahmann 2017).

The results also underscore the ambivalent role of education for explaining gender differences in in adult numeracy. Although it is important in some cases (for example, among older adults in Germany, Japan, Korea, and the Netherlands), in most cases, individual education level and field do not explain a large portion of the gender difference in adult numeracy. This finding could be interpreted in several ways. Firstly, I may not have been able to capture the educational differences that are pertinent to gender differences in adult numeracy using standardised, internationally comparable measures of educational attainment and field of study. There may be different pathways to gender differences in adult numeracy which depend on details of each country's education system at different time points, which have not been captured here. Country-specific policies to consider in this context, which have previously been found to be important for gender and educational outcomes, are the presence of tracking (Bedard & Cho 2010; Scheeren et al. 2018), whether mathematics is a compulsory subject in upper secondary education, the presence of single-sex schooling (Park et al. 2018), curriculum structure (Ayalon 2002; Ayalon & Livneh 2013) and other factors relating to the school and family environment at the time of educational exposure (Legewie & DiPrete 2009, 2012). The role of country-specific educational policies may be particularly important for explaining why gender inequalities in education are *not* associated with gender differences in adult numeracy, which was the case for older adults in the Post-Soviet countries. It is important to note that these older adults grew up under socialism. The standardisation of education under Soviet rule may have suppressed skills inequalities. High female labour force participation, and women's relatively good job opportunities in socialist societies (Kosyakova et al. 2015, 2018) may also be important for explaining gendered skills outcomes for this group of individuals. These factors, as well as what has been referred to as a resurgence of gender inequalities alongside economic liberalisation (Kosyakova et al. 2015), may explain why older women in these societies have comparable levels of numeracy to men, in spite of having completed less education, while younger women, well-educated women are more likely to lag behind their male counterparts.

The relationship between education and adult numeracy may itself be contextually specific, dependent on factors such as educational quality (Hanushek & Zhang 2009; Green & Riddell 2012), and even the way different education levels are coded for use in international datasets (Massing & Schneider 2017). The lack of longitudinal data is a further limitation to this analysis, because it means that associations between aspects of education and numeracy cannot be definitively attributed to education. Moreover, the results may be attributable to selection effects, for example, higher numbers of lower skilled women selecting into higher education as female-dominated areas of study expand.

The analysis is also limited by using variables reflecting only formal education. For the older adults in the sample, a large amount of time has typically elapsed between their formal education experiences and the measurement of their numeracy skills. Since adult numeracy is affected by diverse factors and behaviours across the life course (Desjardins & Warnke 2012), which themselves are influenced by educational attainment, the complete association between education and numeracy may not have been captured. Moreover, education later in life (i.e. adult learning) is known to be important for cognitive skills in adulthood (Hatch et al. 2007; Hertzog et al. 2008; Desjardins et al. 2016) and has not been considered here. Further research is therefore needed on the factors, educational and otherwise, sustaining gender differences among adults across their entire life course.

4.8 Conclusion

This chapter suggests that the relationship between gender differences in education and gender differences in adult numeracy is complex, country-specific, and not always consistent with theoretical expectations. While women's advances in education have had many profound and positive consequences (e.g. Thévenon et al. 2012), there is no necessary relationship between these advances and gender equality in skills outcomes. Inequalities in education are only associated with gender differences in numeracy in contexts (cohorts and countries) where the former inequalities are highly pronounced, and gender differences in numeracy remain in countries and cohorts where women are highly advantaged in the educational sphere. Moreover, gender inequalities in education do not appear to have resulted in gender differences in numeracy skills among older generations of adults in post-Soviet countries. The chapter therefore challenges assertions in the existing literature about the strong relationship between gender differences in educational exposure and gender differences in numeracy and related skills.

It seems that the forces which undergird and emerge from women's achievements in education (such as egalitarian attitudes and enhanced labour market opportunities) can coexist alongside male advantages in adult numeracy – an essential skill for participation in economic and social life. This should serve to temper the bold claims of the gender stratification hypothesis regarding the equalising effect of women's educational participation on numeracy and related skills. Moreover, gender differences in adult numeracy are far from 'explained by' education as conceptualised and measured in this chapter. This somewhat limited explanatory role of education for explaining gender differences in cognitive skills underscores the ambivalent role of education in relation to adult skills. This also reflects the results of previous studies which highlight the importance of considering other factors in adult life as important contributors to adult skills, beyond education (Bynner & Parsons 1998, 2009). The next chapter follows this line of argument by examining the role of occupations and occupational segregation in relation to the gender difference in adult numeracy among the working population.

5. Gender segregation in the labour market and the gender difference in adult numeracy

5.1 Introduction

A life course perspective on adult skills suggests that they not only the result of earlier life experiences and educational exposure, but also result from interactive influences across the entire life course (Elder 1985; Richards & Deary 2005; Richards & Hatch 2011). It also seems that gender differences in numeracy skills increase over the life course (Hyde et al. 1990; Voyer et al. 1995) and are not fully explained by differences in educational experiences (Bynner & Parsons 1998, 2009). After education, the main arena in which skills are developed and maintained in adulthood is the workplace (Schooler et al. 2004; Baldivia et al. 2008; Desjardins & Warnke 2012). This suggests that it is important to consider the relationship between gendered employment experiences and gender differences in adult numeracy. Two main aspects are likely to be important: participating in the paid workforce (as opposed to being economically inactive or unemployed) and the activities that one performs at work. Indeed, Parsons and Bynner have demonstrated that time spent in employment is a crucial determinant of numeracy skills in adulthood (Bynner & Parsons 1997b; Parsons & Bynner 1999). Moreover, the types of tasks performed at work can be considered ‘a form of training’ (Baldivia et al. 2008: 177) which help to instil and develop various cognitive skills as adults progress through their working lives (Kohn & Schooler 1969; Schooler et al. 2004; Hauser & Roan 2007).

As previously discussed, the gender stratification hypothesis suggests that the male advantage in numeracy and related skills is associated with gender inequality in education, the labour market and public life (Baker & Jones 1993; Riegle-Crumb 2005; Guiso et al. 2008; Else-Quest et al. 2010; Kane & Mertz 2012; Reilly 2012; Pekkarinen 2012). From this point of view, women’s participation in the labour market can be expected to be positive for women’s numeracy skills. In other words, the fact that women are increasingly engaged in paid employment can be expected to have an equalising effect on their numeracy skills relative to those of their male counterparts. Indeed, the OECD suggests that women's disadvantage in numeracy skills may be related to their lower levels of labour force participation over the life course (OECD 2013a). However, an alternate perspective notes that, even when they are employed, men and women engage in very different forms of work. This gender segregation in employment may be key to understanding why men and women continue to have different levels of numeracy skills in adulthood.

In this chapter, I use this alternative perspective to explore the influence of employment on gender differences in adult numeracy. Beyond assessing the role of labour force participation per se, I also explore whether gender segregation in employment is implicated in explaining gender differences in adult numeracy. This chapter thereby addresses the second research question posed in the introduction: how are gender differences in adult numeracy related to gender segregation in the labour market? Taking the perspective that using skills in the workplace is crucial to their realisation in adulthood, I use a 'job skills' approach to analysing occupational gender segregation. While previous studies have identified that women use numeracy skills less than men do (Lindemann 2015; Borgonovi et al. 2017; Duchhardt et al. 2017), the approach in this chapter involves identifying the numeracy-intensiveness of occupations, analysing the distribution of men and women across occupations with different levels of numeracy-intensiveness, and using occupational numeracy- intensiveness as novel explanatory variable to explain gender differences in adult numeracy. This approach takes advantage of the rich data on occupational characteristics in PIAAC to create a measure of occupational segregation that is likely to be more closely related to gender differences in adult numeracy than other, more widely used measures of gender segregation in employment.

The research questions addressed in this chapter are:

C1: Are women more likely than men to work in occupations that are low in numeracy-intensiveness?

C2: If so, can this explain their disadvantage in adult numeracy?

5.2 Chapter outline

The following section focuses on the conceptualisation and measurement of gender segregation in employment. It suggests that considering skills use in the workplace, particularly numeracy-intensiveness, could add a new dimension to the understanding of gender segregation. This dimension may be important in its own right, as well as helping explain gender differences in numeracy among working adults. Having stated the hypotheses to be evaluated, the chapter provides an explanation of the data and methodology (section 5.6). Findings are then presented in three stages, and section 5.8 summarises the main findings, stating the limitations and implications for future research, while section 5.9 provides a conclusion.

5.3 Gender segregation in employment: background

Gender segregation in employment is usually understood in terms of 'typically male' and 'typically female occupations'. The uneven distribution of men and women into these gender-congruent occupation types is a consistent and persistent phenomenon across the world. This gender segregation is of great interest to researchers of gender inequality in industrialised societies because of its durability alongside trends such as increasingly egalitarian gender role attitudes, female advances in education, and steady increases in female labour force participation rates (Charles & Grusky 2004; England 2010; Charles 2011). Occupational gender segregation is explained either by gender socialisation arguments which argue that men and women develop divergent preferences, attitudes, and skills which translate into occupational choice (Corcoran & Courant 1985; Beutel & Marini 1995; Charles & Grusky 2004), by structuralist arguments which emphasise the deliberate exclusion of women from certain occupations (Walby 1986; Petersen & Saporta 2004; Reskin & Maroto 2011), or by arguments which foreground the unintended effects of social policies (Estevez-

Abe 2005; Mandel & Semyonov 2006; Mandel 2009; Mandel 2011)[20]. Across these theoretical perspectives, it is recognised that women's greater integration into the labour force has not necessarily led to de-segregation (Meyer 2003); it has even, paradoxically, contributed to a deeper institutionalisation of gender within the occupational structure (Charles 1992).

Occupational gender segregation can be conceptually and empirically distinguished into 'vertical' and 'horizontal' aspects (Semuonov & Jones 1999). Vertical segregation is present when women have less access to occupations associated with power, autonomy, and control over capital and resources (Anker et al. 2003; Charles & Grusky 2004; Charles 2005; Fagan & Burchell 2007; Steinmetz 2012). An example of this is women's lower access to positions of authority, including under-representation in managerial occupations (Rosenfeld et al. 1998; Kraus & Yonay 2000; Dämmrich & Blossfeld 2017). Vertical segregation can be viewed as an instance of the uneven gender distribution of power, status, and resources in society (Connell 1987; Chafetz 1988). On the 'horizontal' dimension, women are concentrated in socially oriented and caring occupations, while men tend to predominate in occupations involving manual labour (Charles & Grusky 2004; Fagan & Burchell 2007; Steinmetz 2012; Levanon & Grusky 2016). Horizontal segregation can also be reflected in the segregation of tasks within workplaces. For example, even in the professional sector of the labour market, women are more likely to undertake tasks centred around care, educating, emotional, and aesthetic labour (Kilbourne et al. 1994; Leuze & Strauß 2014). Horizontal segregation is a key aspect of the gendered division of labour in society (Connell 1987).

The influential work of Maria Charles and David Grusky (Charles & Grusky 2004, 2011) advances the argument that, in contrast to vertical segregation, horizontal segregation is highly resistant to gender-

[20] Economists have tended to explain occupational segregation with reference to human capital theory, arguing that women's early plans for intermittent careers due to childbearing explain their selection into female-dominated employment that accommodates such intermittent working patterns (e.g. Polachek 1985).

egalitarian trends. Since vertical segregation is undergirded by a logic of 'male primacy', i.e. the inherent superiority of men, it declines alongside the decline of this belief in the surrounding culture. In contrast, Charles and Grusky (2004) note, horizontal segregation is resistant to such decline. The highest levels of horizontal segregation, conceptualised along the manual/non-manual divide and measured by the distribution of men and women across detailed occupational categories, are found in socially and culturally progressive countries (such as Sweden), while countries typically viewed as more traditional and conservative (such as Japan) show low levels of horizontal segregation. Charles and Grusky suggest that horizontal segregation does not mirror patriarchal processes, but instead results from individuals enacting cultural scripts associating service orientation with femininity and manual labour with masculinity. These cultural scripts, or 'essentialist ideologies', are reinforced by 'the liberal egalitarian vision of women and men as autonomous agents entitled to equal rights and opportunities' (Charles & Grusky 2011: 334). This explains why this form of segregation is so prevalent in relatively egalitarian societies.

Charles and Grusky's argument strongly emphasises the importance and prevalence of horizontal segregation along the manual/non-manual divide. However, recognising the multidimensionality and complexity of segregation processes (Steinmetz 2012; Bridges 2003; Burchell & Rubery 1990), other research has investigated multiple manifestations of gender segregation in the labour market which do not uniquely reflect either vertical or horizontal logics and may not uniquely manifest either 'male primacy' or 'gender essentialism'. For example, women are more likely to work in the public sector, in smaller workplaces (Burchell 1996), and in jobs involving less complex or qualitatively different skillsets (Kilbourne et al. 1994; Boye & Grönlund 2018). Therefore, segregation analysis set up to demonstrate either 'male primacy' or 'gender essentialism' can overlook segregation across varied forms of working conditions and worker outcomes (Burchell et al. 2015). Moreover, there are important variations across countries and cultures in the structure of segregation, evidence against the notion that segregation is highly consistent in its adherence to the manual/non-manual divide. For example, globally, many women perform manufacturing, technical, and manual labour (Epstein 2007). Moreover, there is evidence that, rather than the manual/non-manual divide being fixed, women are apt to enter male-dominated occupations when there is legal support for them doing this, combined with a shortage of personnel (Reskin & Roos 1990; Epstein 2007).

As well as noting that the manual/non-manual divide is not immutable and that various different forms of segregation in employment exist, researchers have also drawn attention to the continuing relevance of vertical forms of segregation in modern post-industrial labour markets, noting not only the persistent gender pay gap, but also the disadvantageous characteristics of female-dominated occupations and the beneficial characteristics of male-dominated and gender-integrated employment. For example, female-dominated occupations tend to have less stability and fewer opportunities for career progression (Glass 1990; Bihagen & Ohls 2006; Stier & Yaish 2014), less access to training and skill development (Boye & Grönlund 2018), and fewer employment regulations and benefits (Fagan & Burchell 2007; McGrath & DeFilippis 2009; Burchell et al. 2015). Female-dominated occupations are also systematically under-valued, in that the significant presence of women in an occupation causes it to be undergo a process of deskilling and wage devaluation (England 1992; Bolton & Muzio 2008; Levanon et al. 2009; Busch 2018). Therefore, far from being on the decline in contemporary post-industrial societies, vertical stratification is still in operation across many aspects of employment.

It is clear from this discussion that there are many different kinds of gender segregation in employment, each of which may embody a different logic. While some may be easily grouped into the 'male primacy' and 'essentialist' rationalities identified by Charles and Grusky, some do not fit neatly into these designations, or combine elements of both. Moreover, while some forms of segregation are highly consistent across the world, others are very variable across countries and cultures. These allow us to go beyond the concepts of 'essentialism' and 'male primacy' to identify different logics of segregation that divide men and women's working lives, and to analyse their consequences.

5.4 Job skills approach

A useful approach to analysing segregation across more detailed attributes of employment is one which focuses on 'job skills'. Job skills can be defined as the skills demands of a job, measured independently from the skills that individual employees possess (Green 2013; Felstead et al. 2017). In international comparative research, a job skills approach addresses some of the weaknesses of occupational categories, in particular, the fact that the skills requirements of the same occupational category can vary widely across countries (Tijdens et al. 2012). In contrast to an approach that focuses solely on occupational categories, a job skills approach examines the tasks and demands of a particular occupation (in a particular country) and provides an overall rating or classification for each occupation on this basis. While recognising that occupations are central to gender segregation in employment, a job skills approach shifts the focus from the distribution of men and women across occupational categories to describing the attributes of those gender-segregated occupations (Mandel 2016).

A job skills approach has been previously applied to the issue of occupational gender segregation, primarily in the United States, using the Occupational Information Network (O*NET) database, which provides detailed descriptors of occupations in the US labour market. The primary focus of this research has been to establish whether men and women's occupations have different skills demands and working conditions, and whether this contributes to the gender pay gap. For example, Kilbourne et al. (1994) measured occupation-level demand for cognitive skills, physical skills and nurturant social skills. They found that nurturant social skills were associated with lower wages and, due to the dominance of women in occupations requiring these skills, this occupational characteristic is partially implicated in the gender gap in earnings. Similar approaches have been applied to analysing the gender distribution of job complexity, approached as the amount of training required (Polavieja 2007; Boye & Grönlund 2018), with the general implication that women tend to hold less complex jobs.

In these approaches it is ambiguous whether the gender segregation of skill demands represents vertical or horizontal segregation. Job complexity, measured by intensity of skills-related tasks or training demands, is obviously related to pay and career progression (le Grand & Tåhlin 2013; Boye & Grönlund 2018), and also be viewed as an intrinsic aspect of job quality (Eurofound 2012; Green 2013). Therefore, it can be viewed as an instance of vertical gender segregation, reflecting male primacy, whereby the highest quality, most advantageous jobs and working conditions are allocated to men. However, other, more detailed forms of segregation across job tasks and specific skillsets can also be viewed as a form of horizontal segregation, which reflect various logics, assumptions, or norms about the division of labour between men and women, which are not necessarily tied to job complexity or skills intensity.

5.4.1 Segregation by numeracy-intensiveness

In this chapter, building on the job skills approach to analysing gender segregation in employment, I argue that the segregation of occupations according to their numeracy-intensiveness constitutes a previously overlooked form of segregation, which cuts across horizontal and vertical forms of segregation, combining logics of *both* 'male primacy' and 'essentialism'. In this way, numeracy-intensiveness may be a window into understanding uncaptured forms of gender segregation in employment. Through this window, I seek to understand the effects of employment on relative levels of numeracy skills among men and women. How might the gender segregation of numeracy-intensiveness in the workplace combine different segregation logics? For this, we must turn to feminist theory; in particular, gender, science, and technology studies.

Scholars within the field of gender, science and technology concur with segregation researchers that ideals of masculinity and femininity have a key influence on men and women's economic roles. For these scholars, however, masculinity is the dominant influence. Whereas Charles, Grusky and others (e.g. Cech 2013) emphasise women's identification with feminine occupational roles and see male pursuits primarily through the lens of 'male primacy' and manual labour, these theorists emphasise masculinity as a dominant force undergirding all social relations, mostly to the exclusion and oppression of women. However, in spite of its overriding influence, masculinity can take on different variants, beyond the idea that masculinity=physical strength (Connell & Messerschmidt 2005; Connell 2005).

For example, male domination of fields such as engineering, technology, and science cannot be solely explained by either the manual/non-manual divide or by male primacy. Judy Wajcman (Wajcman 1991, 2009) describes two distinct variants of masculinity which play out in employment. The first emphasises practical skill, the other intellectual acuity and analytical ability. The identification of these fields of activity as prototypically masculine relates to an archetypal notion of masculinity as necessitating autonomy over the physical environment in both a physical and cognitive sense (Cockburn 1981; Acker 1990; Wajcman 1991, 2009; Bray 2007; Faulkner 2007). Moss Kanter (1977) further refers to a 'masculine ethic' which 'elevates the traits assumed to belong to men with educational advantages to necessities for effective organisations: a tough-minded approach to problems; analytic abilities to abstract and plan… cognitive superiority in problem-solving and decision-making' (Moss Kanter 1977: 43).

Thus, occupations associated with both analytical skills (such as numeracy), as well as those that involve working with machines, tools, and equipment, could thus be male-dominated by these dual logics of masculinity. This is not only a matter of occupational status, since women are often well-represented in high status, professional fields (Scott et al. 2008). The gender segregation of numeracy-intensiveness at work could therefore reflect and reinforce different gender hierarchies and enactments of masculinity and femininity that are not well-captured by the 'manual/non-manual' divide (Pearse & Connell 2016) and instead combine elements of both horizontal and vertical gender segregation.

5.4.2 Numeracy-intensiveness and gender differences in adult numeracy

How are job skills, particularly numeracy-intensiveness, connected to adult numeracy? The main way the connection between occupations and adult skills has been studied is through measuring the complexity of occupations and exploring to what extent this complexity predicts skills retention and decay over time. Studies show that work complexity – defined as the stimulus variability and intensity of demands of an individual's environment – is beneficial to cognitive function (Kohn & Schooler 1983; Hauser & Roan 2007; Finkel et al. 2009). This is often indexed by higher status occupations (Dartigues et al. 1992; Bonaiuto et al. 1995; Callahan et al. 1996). Equally, individuals may experience negative effects on their cognitive skills through spending time in routine, non-stimulating employment. Two potential mechanisms for the relationship between occupations, tasks, and skills in adulthood have since been suggested. One is a simply 'use it or lose it' hypothesis. Occupations dictate the skills individuals use on a daily basis at work and thus occupations affect individuals' numeracy skills over time (Hultsch et al. 1999). Another suggestion is that exposure to particular work routines and experiences directly alter brain structure and functioning. Maguire and colleagues' famous study on cognitive changes in London taxi drivers (Maguire et al. 2000) demonstrates the plasticity of the adult brain and its responsiveness to occupational stimuli, and the domain-specificity of occupational skills training.

From these studies, we can infer that engaging in numerate activities at work is likely to be an important stimulus for the maintenance and development of numeracy in adulthood. To some extent, this will be simply associated with occupational status: more complex occupations, such as professional and managerial jobs, require more complex problem-solving, the need to adjust to new technologies, and higher levels of mental activity across all cognitive areas (Desjardins & Warnke 2012;

Straesser 2015; Marcolin et al. 2016;). These high-status occupations, may use numeracy to a far greater extent, allow individuals to improve on their initial numeracy levels on entry to the job, even developing specialised skills in numeracy over time.

However, while it is clear that in general, higher status jobs are more complex, the degree to which one uses numeracy on the job is mediated by a number of other factors, such as the industry in which an occupation is located (Straesser 2015). Moreover, not all high-status occupations are high in numeracy-intensiveness. Marcolin et al. (2016) found that some occupations that are typically classified as 'skilled' in fact consist of a high proportion of routine tasks. Numerate tasks are found within a wide range of jobs, not only those that are typically considered numerate or STEM-related (Hoyles et al. 2002). This suggests that occupations need to be analysed individually, rather than assuming that all occupations classified as 'high skilled' according to traditional schema automatically have high numeracy intensiveness.

Research using PIAAC has already demonstrated that individual women tend to use numeracy at work less than men do (Lindemann 2015; Borgonovi et al. 2017). A study using Germany's PIAAC data by Duchhart et al. (2017) goes further, to suggest that women's lower propensity to use skills in the workplace may be one reason for the gender difference in adult numeracy. The authors' interpretation of their findings reflects the 'use it or lose it' perspective on skills described above. However, it must also be acknowledged that there are links between numeracy skill levels to engagement in numerate activities, as well as the other way around. For example, individuals with higher levels of numeracy may select jobs in which those skills can be exercised (Speer 2017). It is entirely possible that both these selection effects and the 'use it or lose' it-type associations are in operation simultaneously when we observe a relationship between occupational numeracy intensity and individuals' numeracy level. This is what is often referred to as reciprocal effects of skills and experiences across the life course, referred to by authors such as Hertzog et al. (2008) and Richards and Sacker (2003).

5.5 Summary and hypotheses

To understand the influence of the gender segregation of employment on gender differences in adult numeracy, this chapter generates a novel measure of segregation based on occupations' numeracy-intensiveness. Numeracy-intensiveness refers to the use of numeracy skills in the workplace. The approach in this chapter rests upon aggregating individual numeracy-use scores to the occupation level, creating a median numeracy-intensiveness score for each occupation. While previous research has focused on the skill demands and working conditions of occupations to explore the gender segregation of employment (England 1992; Kilbourne et al. 1994; Mandel 2016), the numeracy-intensiveness of occupations and potential links to gender differences in adult numeracy are a largely uncharted area of research. The preceding discussion suggests that the numeracy-intensiveness of occupations may be a form of gender segregation that cuts across commonplace conceptualisations of vertical and horizontal segregation, combining elements of both patriarchal gender relations and essentialism.

The characteristics and demands of occupations affect the maintenance and development of adults' cognitive skills. Thus, over time, working in less numeracy-intensive jobs may erode women's numeracy skills. Moreover, the connection between the gender-typing of jobs and their numeracy-intensiveness may exert a broader, normative pressure on the types of economic activities that are deemed to be available and appropriate for women, affecting their initial skills acquisition and their motivation and interest towards numerate activities over time. Gender segregation of employment on the basis of numeracy-intensiveness is therefore expected to influence men and women's relative levels of adult numeracy. In the third second stage of the analysis, the numeracy-intensiveness of occupations is therefore used as an explanatory variable to address the question of what explains individual-level gender differences in numeracy among working adults. The analysis in this chapter evaluates the evidence in favour of two hypotheses:

H1. Women are more likely than men to work in occupations that are low in numeracy-intensiveness

H2. The fact that women are likely to work in less numeracy-intensive occupations than men can partly explain the gender difference in adult numeracy skills.

5.6 Methodology

5.6.1 Data and variables

Data

For this chapter, the analytical sample consists of adults between the ages of 16–65. The sample is restricted to individuals currently in employment (full time or part time), since all of the explanatory variables of interest relate to segregation within the labour market and do not apply to those who are not working. Seventeen countries are included in the analysis[21]. Sample numbers for each country, alongside the total PIAAC sample in each country, are shown in Appendix A5.2.

[21] Canada, Estonia, and Finland could not be included due to the absence of detailed ISCO occupational codes, which were necessary to create the occupation numeracy-intensiveness measure.

Variables

The sample is defined using a variable which categorises individuals' current work status. The main sample were those within the first category, 'employed or self-employed'. For comparison, the frequencies of men and women in each category are detailed in the Appendix A5.1.

<u>Work status categories</u>

- Employed or self-employed
- Retired
- Unemployed
- Student (including work programmes)
- Doing unpaid household work
- Other
- Missing (valid skip, don't know, not stated or inferred).

Occupation-level variables

Measuring numeracy-intensiveness

As part of the aim of the PIAAC study was to ascertain population levels of skill use, in addition to skills proficiency (OECD 2011b), an entire section of the background questionnaire, known as the Job Requirements Approach (JRA) module, was dedicated to reporting levels and types of the use of literacy, numeracy and problem-solving skills, both at home and in the workplace. Here, we are interested in **numeracy skills use in the workplace**, since this will be used to measure country-specific, occupation average levels of numeracy-intensiveness. Respondents were asked about the frequency of activities undertaken in their current or most recent job, involving numbers, quantities, numerical information, statistics or mathematics. The answers were given on a scale from 1 (never) to 5 (every day). For numeracy, the activities were:

- Calculating prices, costs, and budgets
- Calculating fractions, decimals, and percentages
- Using a calculator
- Preparing charts, graphs, and tables
- Using simple algebra or formulas
- Using more advanced maths or statistics such as calculus, complex algebra, trigonometry, or regression techniques.

The OECD used the responses to these questions to construct an index of numeracy skills use in the workplace, using Item Response Theory. The resulting scale was transformed to have a mean of 2 and a standard deviation of 1 across the pooled sample of all participating countries, enabling meaningful country comparisons (see OECD 2013c for more information).

Respondents were also asked further questions about their current or most recent job (see section 2.4.2). The answers to these questions were coded into categories of the International Standard Classification of Occupations (ISCO). Countries provided the data for the public use files at different levels of aggregation. Where possible in the present analysis, three-digit ISCO occupation categories were used. Occupations with fewer than ten employees in a given country are excluded from the analysis. For most countries, this resulted in 70 to 80 occupations in total. For countries where two-digit classifications were used (the USA, Sweden, Ireland), this resulted in 37 occupations per country.

For each country, a median numeracy skills use score was derived for each occupation represented. Using these median scores, occupations were also divided into quartiles, with the first quartile containing the least numeracy-intensive occupations, and the fourth quartile containing the most numeracy-intensive occupations. A full table of occupations and their features by country is given in Appendix A5.5.

Individual-level variables

Having characterised occupations according to their numeracy-intensiveness, in Stage 2 of the analysis, I explore whether women are more likely than men to work in occupations that are low in numeracy-intensiveness. Here, a range of individual-level controls are needed in order to account for possible alternative influences on this outcome. These variables are all based on self-report from the PIAAC background questionnaire. Gender is coded as female=1 so that the coefficient represents the female disadvantage in numeracy-intensive occupations.

Work-related control variables are **industry**, **occupational status,** and **sector of employment**. These variables are all described in detail in Chapter 2. Other important control variables relate to education. As well as being strongly related to adult numeracy itself, **education level and field** are also related to occupations. For example, individuals who pursue gender-typical fields of study often work in related, gender-typical occupations (Smyth & Steinmetz 2008). The operationalisation of level of completed education and field of study is described in Chapter 2. The other control variables are **age** group dummies (16–24, 35–44, 45–54, 55–64 compared to 25–34); **immigrant status** (1st or 2nd generation immigrant vs. all others) and **parents' education level** (at least one parent tertiary vs. both parents below tertiary).

5.6.2 Methods of analysis

Stage 1: Generating the numeracy-intensiveness scores for occupations

The first descriptive method used is to compare the average (mean) numeracy score for men and women across the different work status categories. Then, focusing in on the occupational level, I aggregate individual numeracy-use scores to the occupation level to create an 'occupation numeracy-intensiveness score', based on the median within each occupation. This enables comparison of numeracy-intensiveness across occupations.

Stage 2: Are women less likely to work in numeracy-intensive occupations?

To answer this question, occupation numeracy-intensiveness scores are assigned back to the individual level and compared descriptively to detect differences between men's and women's occupations. The question is answered for each country by comparing occupation numeracy-intensiveness scores by gender, as well as by dividing occupations into quartiles based on their numeracy-intensiveness and assessing the average level of employment in each quartile of occupations, overall and by gender. To provide a more robust estimate of whether women are more likely than men to work in occupations low in numeracy-intensiveness, I also model this outcome in Table 5.2, including a range of individual-level controls. These analyses are presented separately by country to enable cross-country comparison.

Index of segregation

To assess the level of gender segregation across occupations in different quartiles of numeracy-intensiveness, I also calculate a dissimilarity index for each country. The Index of Dissimilarity, originally developed by Duncan and Duncan (1955), indicates how many men or women would have to change their occupation in order to arrive at an equal distribution in the labour market (Blossfeld et al. 2015: 25). The index can be represented by the following equation (adapted from Steinmetz 2012: 59):

(1) $$D = \frac{1}{2} \sum_{j=1}^{J} \left| \frac{F_j}{F} - \frac{M_j}{M} \right|$$

The four quartiles of occupation numeracy-intensiveness is represented by j (j = 1,…,J); F_j is the number of women in j; M_j is the number of men in j; and F(M) is the total number of female (male) employees. D equals zero where there is total equality of distributions, while 1 indicates complete dissimilarity (Steinmetz 2012). Dissimilarity indices are also computed for occupations (ISCO one digit) and industries (Singelmann classification) to compare the level of segregation based on these different measures.

Stage 3: Do gender differences in occupation numeracy-intensiveness explain gender differences in adult numeracy?

To answer this question, this chapter uses a similar modelling strategy to the previous chapter. Model 0 calculates the gender difference in mean numeracy score with no covariates. Model 1 is used to calculate the gender difference in mean numeracy score with the covariates from Chapter 4 relating to education and socio-demographic background (X_i). We add variables representing the sector of employment and occupational status ($jobchar_i$) to Model 1 (Model 2) In Model 3, the numeracy-intensiveness of an individual's occupation (num) is added to the model. The gender coefficient β_1 then represents the male advantage in numeracy when holding this variable constant. The gender coefficients from Models 2 and 3 can then be compared to assess how much of the initial gender difference was 'explained' by the numeracy-intensity of individuals' occupations, over and above the other job characteristics. The logistic models predicting individuals' likelihood of reaching high and low skill levels (the PIAAC international benchmarks) proceed in a similar fashion[22].

Model 0: $y_i = \beta_0 + \beta_1\, male_i + \varepsilon_i$

Model 1: $y_i = \beta_0 + \beta_1\, male_i + \beta_k X_i + \varepsilon_i$

Model 2: $y_i = \beta_0 + \beta_1\, male_i + \beta_k X_i + \beta_k\, jobchar_i + \varepsilon_i$

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[22] For more detail on the specification of these logistic models, refer to Chapter 2.

Model 3: $y_i = \beta_0 + \beta_1 \, male_i + \beta_k \, X_i + \beta_k \, jobchar_i + \beta_k \, num_i + \varepsilon_i$

5.7 Results

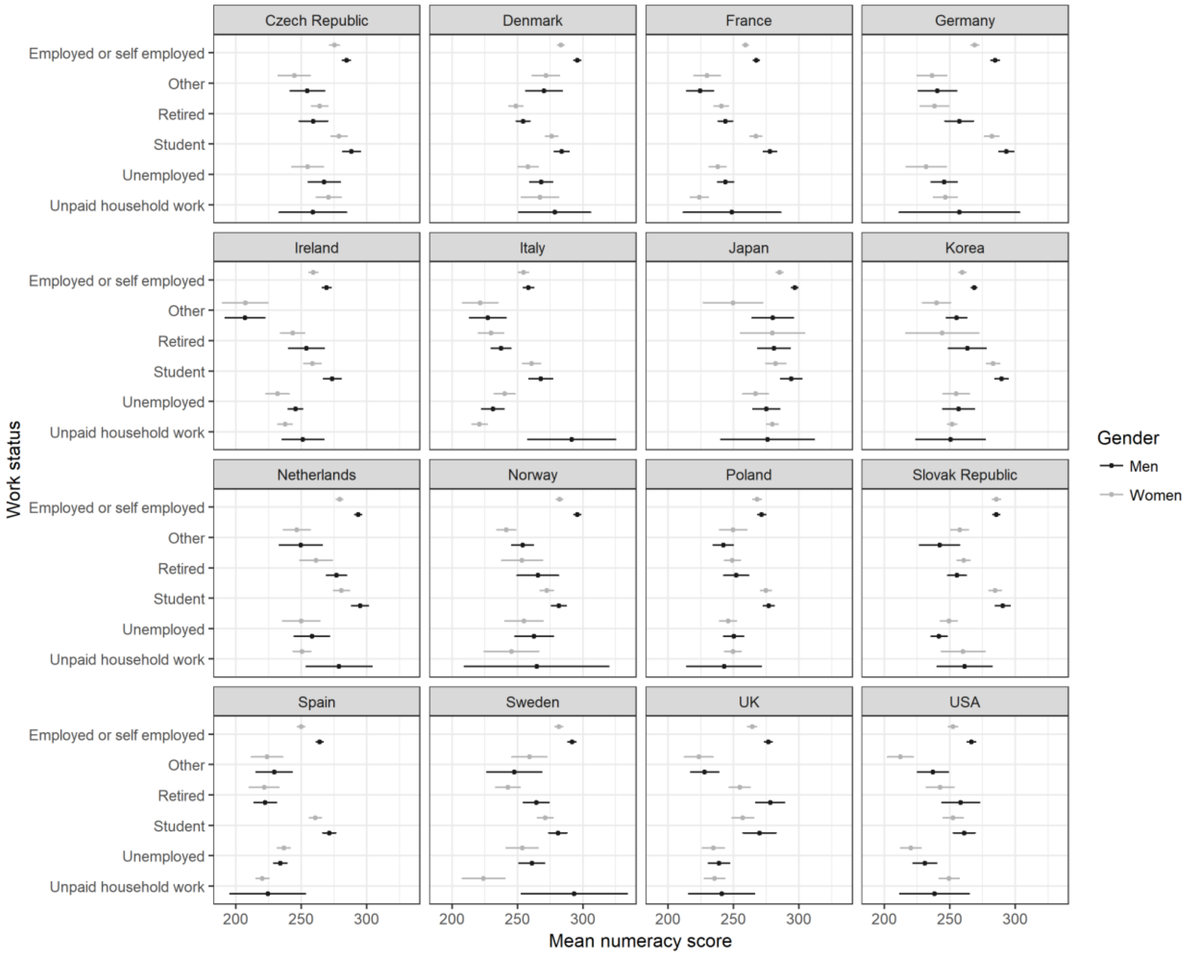
5.7.1 Adult numeracy by work status

Since this chapter uses a selective sample of employed adults, the first part of the analysis assesses the numeracy skills of men and women according to their work status. Figure 5.1 presents the average score on the PIAAC numeracy assessment, together with bars representing 95% confidence intervals, for men and women in each of the following categories: employed (including self-employed and employees, both full-time and part-time); unemployed; retired; students (including work programmes and apprenticeships); unpaid household work and an 'other' category, which includes people who cannot work due to disabilities. When viewing this chart, it should be borne in mind that the size of the various groups varies widely across countries. This is reflected in the width of the confidence intervals. For example, in most countries, the number of men in the category 'unpaid household labour' is very low, so the estimate of adult numeracy among this group is rather uncertain. Furthermore, the samples sizes in groups other than 'employed' may not always be large enough to detect differences between men and women within these groups.

In most countries, women doing unpaid household work have the lowest adult numeracy of all groups. This is particularly the case in France, Italy, and Sweden. This may be related to the fact that female employment rates are relatively low in Italy and are known to be strongly related to educational attainment (Misra et al. 2007; Boeckmann et al. 2015). We may therefore expect women in the labour force in Italy to be highly skilled, and thus the gender difference in adult numeracy between men and women in employment may be lower than in other countries where the female labour force is more heterogeneous. This does appear to be the case to some extent in Italy; yet, there is still a notable gender difference in adult numeracy among employed adults in Spain and France, as well as in Japan and Korea, where female labour force participation rates are similarly low. However, since these results do not control for educational attainment they may obscure complex selection effects.

In most countries, the gender difference in adult numeracy among adults in employment is the most notable gap of all. There are some exceptions, for example the gender difference in adult numeracy among retired men and women is particularly large in Sweden, the UK, and Germany. However, the main message from Figure 5.1 is that gender differences in adult numeracy are pronounced even between men and women who are employed. It therefore seems that, at least when it comes to adult numeracy, the gender stratification hypothesis is unsuccessful at explaining why gender differences remain in this sample of industrialised, OECD countries, in that accessing employment does not seem to equalise women's numeracy skill levels. This points to the need to explore the factors *within employment* which might explain these gender differences.

Figure 5.1 Adult numeracy by work status and gender, adults aged 16–65, PIAAC 2012

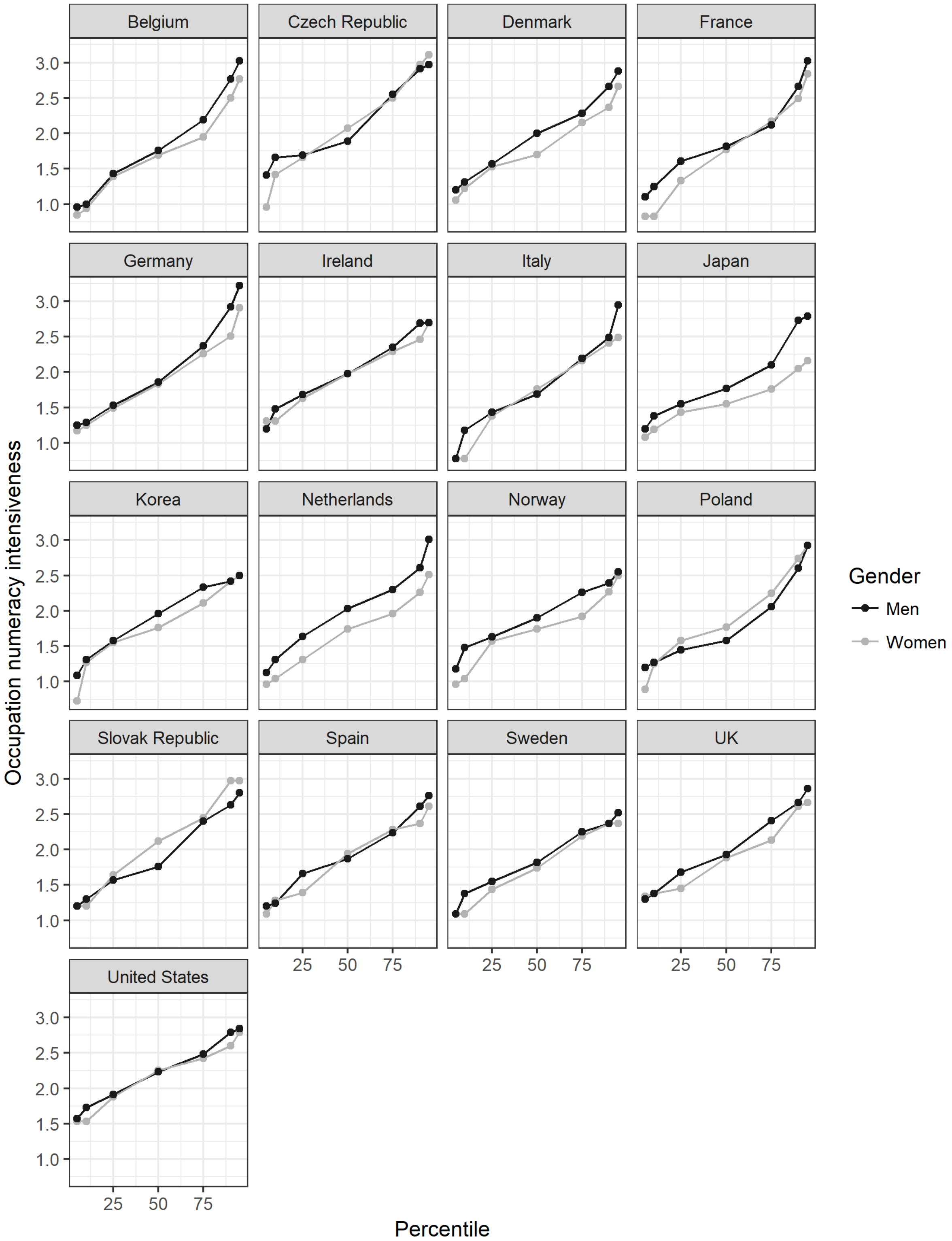


Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Belgium did not provide data for this variable and working adults were selected for the analysis on the basis of an alternative variable ('edwork', a derived variable summarising individuals' education and work status).

5.7.2 Are women more likely to work in less numeracy-intensive occupations?

Occupation numeracy-intensiveness scores were derived for each occupation represented within each country's dataset of working adults. These scores, alongside scores for other types of workplace skills use (including reading and writing), are displayed in Appendix A5.4. Figure 5.2 shows how these occupational numeracy-intensiveness scores are distributed between men and women. It shows the percentile distribution of 'numeracy-intensiveness' for women (grey line) and men (black line). In some countries there is very little difference between men and women's occupations (for instance, Ireland and the USA). In others, men's occupations are higher in numeracy-intensiveness than women's occupations across the entire distribution (for instance, Japan, the Netherlands), providing convincing evidence in favour of Hypothesis 1. In a third group of countries (Sweden, Norway, France), the differences are mainly observable at the bottom of the distribution, suggesting that even among occupations that are low on this scale, men's occupations are more numeracy-intensive. In a further notable pattern, gender differences emerge at the top of the distribution (Germany, Belgium, Italy). The UK, Denmark, and Korea show more of a difference in the middle of the distribution and, finally, Poland, the Czech Republic, and the Slovak Republic show higher numeracy-intensiveness in women's occupations (although there is some distributional variation). Overall, these results show that the gender distribution of occupational numeracy-intensiveness is highly country-specific and varies across values of this variable. In some countries, we see clear evidence in favour of Hypothesis 1, while in other countries this is not so clear, or there is variation across the distribution of occupational numeracy intensiveness. This suggests that it is worth exploring in detail which occupations are represented at various points of the occupation numeracy-intensiveness distribution and whether examining male and female employment rates in those occupations can illuminate these patterns further. Figure 5.2 also suggests that any measure of gender segregation by numeracy-intensiveness must consider the share of men and women across occupations that are found in different parts of the numeracy-intensiveness distribution.

Figure 5.2 Percentiles of occupation numeracy-intensiveness by gender



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

Table 5.1 provides a more detailed look at the types of employment that are found across the four quartiles of occupation numeracy-intensiveness. For each country, the first row of the table shows the percentage of all female employment that is found in each quartile, with the equivalent for men in parentheses. The second row gives examples of common occupations found in each quartile. Female-dominated occupations are highlighted in bold, male-dominated in italics, and gender-integrated occupations are given in plain text. Table 5.1 provides only a small selection of occupations. The complete set of each country's occupations and their numeracy-intensiveness scores is given in Appendix A5.5.

Table 5.1 Employment rates and example occupations in each quartile of occupation numeracy-intensiveness

Country		Q1 (lowest)	Q2	Q3	Q4 (highest)
Belgium	*Percentage female employment (male)*	25.96 (23.6)	31.15(27.55)	25.46 (15.95)	17.43 (32.89)
	Example occupations	**-Social and religious professionals** **-Childcare workers** *-Assemblers*	**-Nursing and midwifery professionals** **-Cashiers and ticket clerks**	*-Metal processing and finishing plant operators* -Administration professionals	*-Engineering professionals* -Higher education teachers *-Finance professionals*
Czech Republic	*Percentage female employment (male)*	30.95(21.81)	13.96 (31.58)	24.34 (20.65)	30.75(25.96)
	Example occupations	**-Childcare workers** **-Personal care workers** *-Manufacturing labourers*	-Bus drivers -**Hairdressers**	**-Other health professionals** **-Medical technicians** *-Metal processing and finishing plant operators*	*-Engineering professionals* -**Finance professionals**
Denmark	*Percentage female employment (male)*	32.07(21.68)	13.96(17.82)	13.67(26.65)	25.44(33.86)
	Example occupations	**-Other health professionals** **-Secretaries** **-Childcare workers** *-Manufacturing labourers*	**-Cleaners** **-Hairdressers** -Authors and journalists	-Administration professionals -Secondary teachers	-Business services agents -Finance professionals *-Engineering professionals*

France	*Percentage female employment (male)*	34.27(23.58)	16.4(25.2)	30.01(30.24)	19.33(20.99)
	Example occupations	**-Childcare workers** **-Cashiers and ticket clerks** -*Bus drivers*	**-Social and religious professionals** *-Cooks* *-Assemblers*	**-Administration professionals** **-Secondary** **Teachers** *-Metal processing and finishing plant operators* **-Other health professionals**	-Business services agents -Finance professionals -*Engineering professionals*
Germany	*Percentage female employment (male)*	29.01(22.9)	21.39(24.92)	25.17(24.13)	24.43(28.05)
	Example occupations	**-Social and religious professionals** **-Childcare workers** *-Assemblers*	**-Hairdressers** -*Construction workers*	-*Business services agents* -Medical professionals -*Legal professionals*	-Engineering professionals -Finance professionals
Ireland	*Percentage female employment (male)*	27.84(25.98)	30.56(27.05)	18(16.35)	23.6(30.62)
	Example occupations	**-Personal care workers** **-Cleaners** *-Labourers*	**-Clerical support workers** *-Assemblers*	**-Sales workers** **-Health associate professionals**	-Business and Administration professionals -Administration and commercial managers
Italy	*Percentage female employment (male)*	29.98(26.3)	19.2(22.89)	25.87(25.62)	24.95(25.19)
	Example occupations	**-Secretaries** **-Personal care workers** **-Waiters** *-Assemblers*	-*Machine operators* **-Hairdressers** **-Clerical support workers**	-Salespersons -Artistic professionals **-General office clerks**	-Finance professionals -*Sales agents* -**Tellers and clerks**

Japan	*Percentage female employment (male)*	24.41(15.78)	40.91(21.67)	24.6(34.05)	10.08(28.5)
	Example occupations	**-Personal care workers** **-Childcare workers** -*Drivers*	-**Health associate professionals** **-Sales workers**	-*Secondary teachers* -**Primary teachers** **-General office clerks** -*Sales agents/brokers*	-*Engineering professionals* -*Higher education teachers* -*Finance professionals*
Korea	*Percentage female employment (male)*	36.66(23.95)	9.73(15.55)	28.85(21.51)	24.76(38.99)
	Example occupations	**-Waiters and bartenders** **-Personal care workers** **-Childcare workers** -Market gardeners	-*Mining and construction labourers* -*Assemblers* -Social and religious professionals	-Salespersons -*Higher education teachers* **-Nursing and midwifery**	-Chief executives -*Engineering professionals* -*Sales agents and brokers* -**Numerical clerks** -*Clerical support workers* -*Government associate professionals*
Netherlands	*Percentage female employment (male)*	34.53(16.91)	24.08(19.37)	24.02(25.73)	17.37(37.98)
	Example occupations	-*Bus drivers* **-Childcare workers** **-Personal care workers** **-Secretaries**	-Secondary teachers **-Primary teachers** **-Waiters and bartenders** -*Machinery mechanics*	-Professional services managers -Administration professionals -Higher education teachers -Doctors -**Office clerks**	-Chief executives -*Engineering professionals* -*Sales agents and brokers* -*Finance professionals* -**Numerical clerks**

Norway	*Percentage female employment (male)*	34.98(19.19)	24.39(19.63)	23.98(32.1)	16.65(29.08)
	Example occupations	**-Childcare workers** **-Personal care workers** **-Cleaners** -*Bus drivers*	-**Primary teachers** **-Shop salespersons** **-Nursing and midwifery** -*Mechanics*	-Higher education teachers -**Legal, social and religious assoc. professionals** -Sales workers	-*Chief executives* -*Engineering professionals* -Sales agents and brokers -**Numerical clerks**
Poland	*Percentage female employment (male)*	17.22(32.05)	23.81(27.57)	32.12(16.77)	26.85(23.62)
	Example occupations	**-Childcare workers** -*Construction workers* -*Assemblers* -*Agricultural labourers* -**Garment workers** **-Cleaners**	-*Mechanics* **-Primary teachers** **-Secretaries** **-Personal care workers** -*Market gardeners and crop growers* -*Drivers*	-**Secondary teachers** **-Legal professionals** **-Medical technicians** **-Shop salespersons** -*Mining and construction supervisors*	-*Chief executives* -**Business services and administration managers** -*Engineering professionals* -**Finance professionals** **-Administration professionals**

Slovak Republic	*Percentage female employment (male)*	18.31(28.1)	25.54(25.57)	27.83(18.61)	28.31(25.71)
	Example occupations	**-Cleaners** *-Transport and storage labourers* **-Childcare workers** **- Personal care workers** *-Construction workers* *-Assemblers* *-Agricultural labourers*	**-Primary teachers** **-Nursing and midwifery** **-Childcare workers** *-Mechanics* *-Bus drivers* -Craft workers	-Professional services managers -**Secondary teachers** **-Clerical support workers** **-Shop salespersons**	- Business services and administration managers - *Engineering professionals* -Finance professionals -**Financial and mathematical associate professionals** **-Social and religious professionals** **-Numerical clerks**
Spain	*Percentage female employment (male)*	33.04(23.36)	14.9(28.71)	36.91(27.6)	15.15(20.33)
	Example occupations	-Waiters and bartenders **-Childcare workers** **-Personal care workers** *-Mining and construction labourers* *-Animal producers*	**-Nursing and midwifery** **-Primary teachers** *-Mechanics* *-Drivers*	-Legal professionals -**General office clerks** **-Secretaries** **-Sales workers** -*Metal workers* -	- *Engineering professionals* -Finance professionals *-Regulatory government associate professionals* -Sales agents and brokers -**Numerical clerks**

Sweden	*Percentage female employment (male)*	32.22(24.49)	24.36(23.66)	18.06(16.37)	25.36(35.48)
	Example occupations	**-Personal care workers** *-Assemblers* *-Drivers*	**-Legal social and cultural professionals** *-Building trades workers* **-Teaching professionals** **-Health professionals**	**-Health associate professionals** **-Numerical, customer services clerks** **-Sales workers** *-Metal workers*	-Business and administration professionals *-ICT professionals* *-Services managers*
USA	*Percentage female employment (male)*	21.9(20.34)	19.18(19.14)	41.93(32.23)	16.99(28.29)
	Example occupations	**-Personal care workers** **-Legal, social and cultural professionals** **-Cleaners** *-Manufacturing/construction labourers*	*-Drivers* *-Skilled agricultural workers* **-Personal service workers** **-Health associate professionals**	**-Health professionals** -Teaching professionals **-Customer services clerks** **-Sales workers** *-Building trades workers* *-Metal workers*	-Business and administration professionals -Numerical and material recording clerks -Administrative and commercial managers

UK	*Percentage female employment (male)*	32.64(24.2)	23.99(24.25)	22.42(19.64)	20.95(31.91)
	Example occupations	**-Childcare workers** **-Personal care workers** **-Waiters and bartenders** *-Manufacturing and transport labourers* *-Drivers*	**-Clerical support workers** **-Social and religious professionals** **-Secretaries** *-Metal workers* *-Electricians* *-Mining and construction labourers* *-Assemblers*	**-Primary teachers** **-Administration professionals** **-Shop salespersons** *-Stationary plant and machine operators*	**-Business services and administration managers** *-Trade managers; construction managers* *-Engineering professionals* -Finance professionals -Finance and mathematical associate professionals **-Numerical clerks**

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Bold = female-dominated occupation; italics = male-dominated occupation, plain text = gender-integrated occupation.

In most countries, women are over-represented in the bottom quartile of occupation numeracy-intensiveness. In this quartile, we find some low skilled, male-dominated manual jobs, such as bus drivers and labourers, as may be expected. However, in all countries, we also find care occupations such as personal care workers, childcare workers, and service jobs such as hairdressers, waiters, and ticket clerks. This is somewhat surprising, given that some of these jobs are supposedly relatively skilled compared to the aforementioned manual occupations. For example, according to the International Standard Classification of Occupations, childcare workers are classified as ISCO 5, a category that denotes semi-skilled occupations. However, it appears that childcare is universally associated with low numeracy-intensiveness. In the Nordic countries, jobs in the lowest quartile of occupational numeracy-intensiveness account for a high proportion of female employment. For example, in Denmark, Norway, and Sweden, around 30 per cent of all employed women work in occupations in the lowest quartile of numeracy-intensiveness, compared to around 20 per cent of men.

At the other end of the spectrum, in the highest quartile of numeracy-intensiveness, we find many professional and managerial occupations, as well as occupations in finance and engineering. It is striking that, in almost all countries, most of these occupations are either male-dominated or gender-integrated, while almost none are female-dominated. In diverse countries such as Japan, Spain, Norway, and the USA, women's employment in this highest quartile is much lower than men's. A second observation is that female-dominated, high numeracy-intensiveness occupations do exist in most countries. For instance, bank tellers and numerical clerks are always female-dominated occupations and are nearly always in the highest numeracy-intensiveness quartile. However, these occupations account for a relatively low proportion of overall female employment and are generally comparatively routine in nature. In contrast, male-dominated, high numeracy-intensiveness occupations are usually associated with significantly more autonomy and authority, encompassing jobs such as managers, chief executives, and engineers.

The post-Soviet countries are very distinctive in this analysis. Although Poland, the Czech Republic, and the Slovak Republic exhibit a pattern common across all countries, in that care occupations are low in numeracy-intensiveness, many male-dominated manual occupations also fall into the bottom quartile, meaning that overall, it is relatively highly populated by men. Moreover, women are much better represented in the highest numeracy-intensiveness quartile, mainly in private sector management and finance occupations, which in many cases are female-dominated occupations. This may explain why in these countries, although employment is certainly gender-segregated, a male advantage in occupational numeracy-intensiveness is not observable (see Figure 5.2).

In Table 5.2, I provide a more rigorous test of Hypothesis 1, whether women are more likely to work in occupations low in numeracy-intensiveness, by modelling the influence of being female on average occupation numeracy intensiveness score and on the likelihood of working in an occupation in the lowest numeracy-intensiveness quartile. Model 1 shows the influence of gender on each of these outcomes, while Model 2 controls for occupational status (ISEI), economic sector, and industry sector, with the coefficient for 'social services sector' included in the table. This analysis confirms the descriptive findings above, in favour of Hypothesis 1, showing that women have lower average occupation numeracy-intensiveness scores than men in many countries. However, it also shows that in some cases, the over-representation of women in the lowest quartile of numeracy-intensiveness disappears when controlling for industry sector (see the substantial reduction in the gender coefficient between M1 and M2 in most cases). This suggests that the over-representation of women in the lowest numeracy-intensiveness quartile is largely explained by their over-representation in the social services sector, in which occupations are very likely to be low in numeracy-intensiveness (see the large coefficients for 'social services sector', in particular, France, Italy, Korea, the Netherlands, Norway, and the UK). However, on average, except in the post-Soviet nations, women are still disadvantaged in occupational numeracy-intensiveness even when controlling for industry sector, occupational status and economic sector of employment.

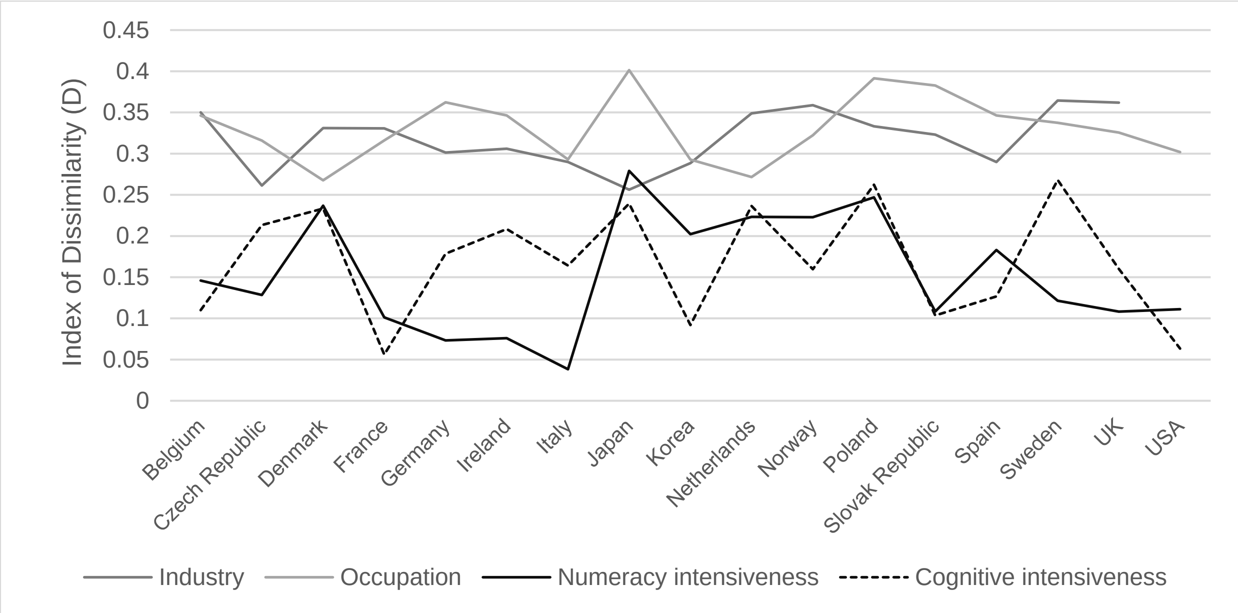
Table 5.2 Gender, industry sector and occupation numeracy-intensiveness

		Average numeracy-intensiveness score				Bottom quartile (odds ratio)			
		M1		M2		M1		M2	
		Coef	SE	Coef	SE	OR	SE	OR	SE
Belgium	**Gender(female)**	-0.16***	0.02	-0.08***	0.02	1.12***	0.09	0.71***	0.1
	Social services			-0.43***	0.04			3.09***	1.33
Czech Republic	**Gender(female)**	-0.00	0.02	0.05*	0.02	1.63***	0.17		
	Social services			-0.22	0.22				
Denmark	**Gender(female)**	-0.18***	0.02	-0.06***	0.02	1.74***	0.14	0.99**	0.09
	Social services			-0.36***	0.03			4.64***	0.81
France	**Gender(female)**	-0.14***	0.01	-0.05***	0.01	1.72***	0.1	1.40***	0.13
	Social services			-0.46***	0.03			12.79***	2.09
Germany	**Gender(female)**	-0.11***	0.02	0.02	0.02	1.38***	0.13	0.83***	0.09
	Social services			-0.53***	0.05			9.22***	1.8
Ireland	**Gender(female)**	-0.07***	0.02	0.05***	0.03	1.09***	0.1	0.58***	0.08
	Social services			-0.5	0.02			12.48***	3.2
Italy	**Gender(female)**	-0.06*	0.03	-0.02	0.02	1.21***	0.12	0.98***	0.15
	Social services			-0.50***	0.04			11.79***	3.87
Japan	**Gender(female)**	-0.29***	0.01	-0.19***	0.03	1.74***	0.18	1.28***	0.05
	Social services			-0.46***	0.03			7.18***	0.48
Korea	**Gender(female)**	-0.15***	0.02	-0.03	0.01	1.84***	0.13	1.11	0.11
	Social services			-0.49***	0.02			21.56***	6.43
Netherlands	**Gender(female)**	-0.30***	0.02	-0.10***	0.02	2.60***	0.21	1.34***	0.14
	Social services			-0.55***	0.02			20.82***	4.21
Norway	**Gender(female)**	-0.21***	0.02	-0.04***	0.01	2.17***	0.18	0.91***	0.11
	Social services			-0.44***	0.02			9.98***	2.36
Poland	**Gender(female)**	0.11***	0.03	0.04	0.02	0.44***	0.04	0.64***	0.07
	Social services			-0.17***	0.05			0.82***	0.24
Slovak Republic	**Gender(female)**	0.11***	0.02	0.11***	0.02	0.58***	0.06	1.13***	0.15
	Social services			-0.44***	0.03			1.21***	0.44
Spain	**Gender(female)**	-0.06**	0.02	0	0.02	1.62***	0.16	1.28***	0.05
	Social services			-0.33***	0.04			7.18***	0.48
Sweden	**Gender(female)**	-0.13***	0.02	0.02	0.01	1.45***	0.11	0.55***	0.09
	Social services			-0.33	0.02			7.88***	1.8
UK	**Gender(female)**	-0.12***	0.02	0.03*	0.01	1.51***	0.15	0.80***	0.11
	Social services			-0.39***	0.02			25.66***	6.97
USA	**Gender(female)**	-0.09***	0.02	-0.07***	0.01	1.11***	0.12	1.03***	0.12

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Models control for parents' education, immigrant background, age group, educational attainment, field of study, occupational status (ISEI), economic sector (not shown), and industry sector. Industry sector is not available for the USA. The 'bottom quartile' model for the Czech Republic would not converge so results are missing.

For a sense of the overall level of segregation by numeracy-intensiveness, Figure 5.3 plots the index of dissimilarity based on female and male employment in the four numeracy-intensiveness quartiles, alongside alternative indicators of segregation, based on occupations and industries, and overall cognitive intensiveness (calculated by generating quartiles of a principal component combining all of the cognitive workplace skills measures at the occupational level). Segregation based on numeracy-intensiveness (the solid black line) is much more variable than other forms of segregation. It is relatively high in Denmark, Japan, Korea, the Netherlands, Norway, and Poland (however, in Poland it reflects female advantage rather than disadvantage – see Figure 5.2). It appears to track to some extent with both industry segregation and occupational segregation but does not mirror them completely. It is also distinct from segregation on the basis of the cognitive intensiveness of occupations. For example, in Ireland, Germany, the Czech Republic, and Sweden, segregation by cognitive intensiveness is more pronounced than segregation by numeracy-intensiveness, while the opposite is the case in Japan and Korea. This suggests that it is a hybrid form of segregation that is not completely captured by traditional indices of gender segregation in employment, or by gender segregation in the general skill requirements of occupations.

Figure 5.3 Indicators of gender segregation in the labour market in 17 OECD countries



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. 'Industry' = dissimilarity index across Singelmann industry categories. 'Occupation' = Index of Dissimilarity across 1-digit occupations. 'Numeracy-intensiveness' = dissimilarity index across numeracy-intensiveness quartiles. 'Cognitive intensiveness' = dissimilarity index across cognitive intensiveness quartiles (Principal component of generic skills use in occupations).

This chapter has so far shown that segregation of employment by numeracy-intensiveness is very pronounced in some countries. It has thereby found evidence in support of the first hypothesis in selected countries. The next part of the chapter turns to whether this aspect of gender segregation in employment is useful for explaining why working men tend to have better adult numeracy skills than working women.

5.7.3 To what extent can numeracy-intensiveness of occupations explain the gender difference in adult numeracy?

To assess the evidence in favour of Hypothesis 2 - the extent to which gender differences in occupational numeracy-intensiveness, where they are present, can explain gender differences in adult numeracy -Table 5.3 displays the gender coefficients from three stages of a regression model predicting the average gender difference in adult numeracy. Here, we are interested in observing whether the numeracy-intensiveness of occupations plays an additional role, over and above industry sector and occupational status. Model 1 regresses adult numeracy score on gender, age, immigrant status, parental education, educational attainment, and field of study. Model 2 adds variables measuring sector of employment and ISEI score. Models 3a to 3c add three separate variables representing female disadvantage in accessing numeracy-intensive occupations. Model 3a adds a continuous variable representing the numeracy-intensiveness score of an individual's occupation. This variable is negatively coded so that higher scores represent occupations that are lower in numeracy-intensiveness. Model 3b adds to Model 2 a dummy variable representing whether an individual's occupation is found in the lowest quartile of occupational numeracy-intensiveness. Model 3b adds to Model 2 a dummy variable representing whether an individual's occupation is found in the highest quartile of numeracy-intensiveness. Gender coefficients which represent a statistically significant change from the previous model are highlighted in grey[23].

[23] This comparison is made using the SUV method described in Chapter 2. Models 3a to 3c are each compared to Model 2.

Table 5.3 Gender coefficients from OLS regression model, five specifications

	Model 0		Model 1		Model 2		Model 3a: average numeracy-intensiveness score		Model 3b: bottom quartile		Model 3c: top quartile	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Belgium	14.14***	1.93	16.46***	1.82	**15.27*****	1.80	14.6***	1.83	15.85***	1.80	15.19***	1.86
Czech Republic	9.04***	2.48	8.36**	2.99	8.68**	2.93	10.80***	3.07	9.19***	2.90	10.71***	3.09
Denmark	12.62***	1.81	16.51***	1.82	**14.75*****	1.92	**14.22*****	1.90	15.13***	1.91	15.07***	1.90
France	7.95***	1.59	9.44***	1.56	8.69***	1.67	**7.97*****	1.65	**7.57*****	1.65	8.8***	1.68
Germany	15.50***	2.08	16.64***	2.30	**14.17*****	2.24	15.02***	2.33	15.02***	2.34	15.54***	2.35
Ireland	10.50***	1.80	14.58***	1.80	13.23***	1.92	13.64***	1.94	13.06***	1.92	12.86***	1.89
Italy	3.51	2.40	8.47***	2.39	7.41**	2.69	**6.37****	2.67	5.99**	2.67	6.29*	2.66
Japan	11.52***	1.79	7.65***	1.93	7.27***	2.04	**4.64****	1.92	**6.65****	1.96	**5.45****	1.94
Korea	8.89***	1.50	6.03***	1.47	6.72***	1.57	6.11***	1.63	5.95**	1.62	5.94***	1.62
Netherlands	14.12***	1.72	12.93***	1.66	11.18***	1.57	11.39***	1.65	11.32***	1.61	11.33***	1.60
Norway	13.87***	1.87	16.16***	1.80	**12.59*****	1.80	12.28***	1.76	12.72***	1.78	12.52***	1.78
Poland	3.70	2.04	9.18***	2.06	9.86***	2.16	10.67***	2.18	10.48***	2.16	9.98***	2.13
Slovak Republic	-0.02	1.82	0.65	1.84	0.92	1.86	2.12	2.12	1.47	2.09	1.35	2.07
Spain	14.30***	1.85	16.32***	1.66	16.12***	1.78	15.80***	1.91	15.09***	1.92	15.07***	1.91
Sweden	10.01***	1.88	12.40***	1.93	**7.75*****	2.06	8.67***	2.04	8.27***	2.07	8.58***	2.05
UK	12.45***	2.01	12.21***	1.99	**10.97*****	2.13	11.36***	2.17	11.36***	2.12	11.24***	2.10
USA	13.71***	2.11	15.80***	1.86	15.12***	1.77	15.08***	1.73	15.32***	1.75	15.15***	1.77

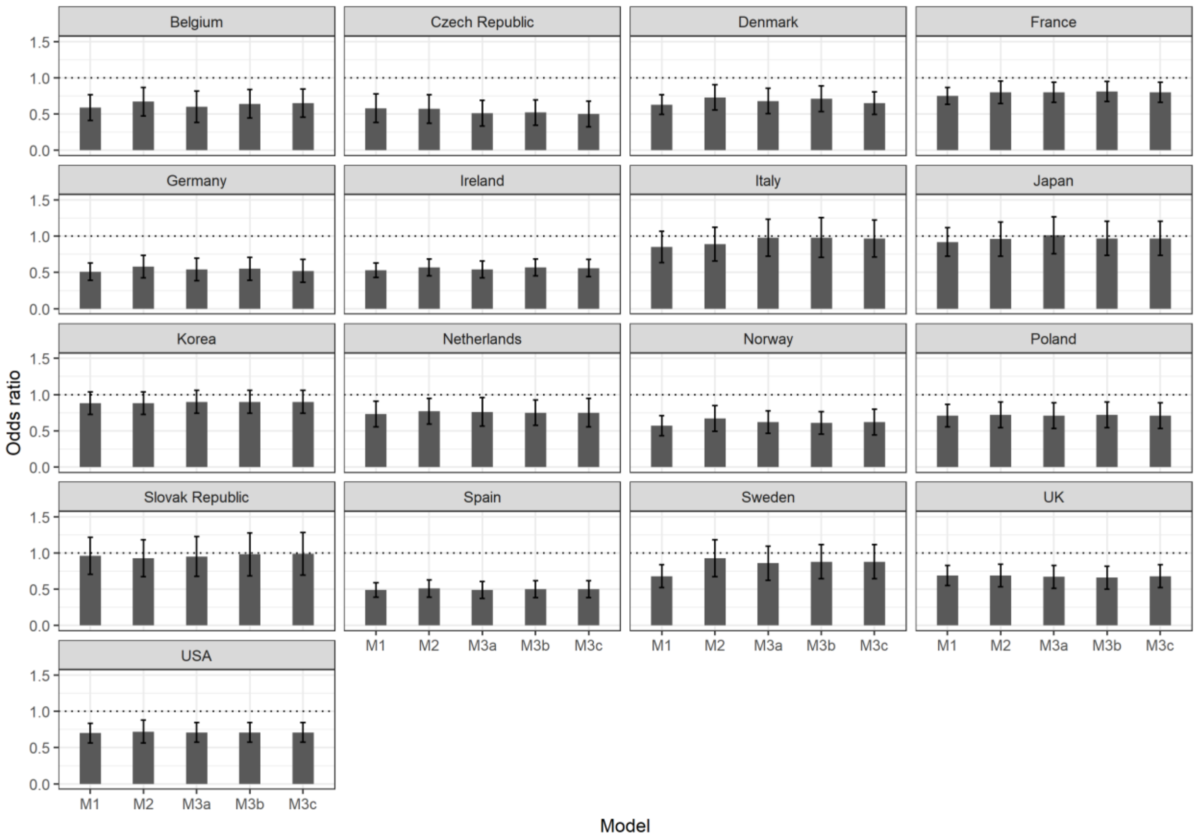
Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. p < 0.05, * p <0.01, ** p <0.001,***. Model 0 = raw gender difference. Model 1 regresses adult numeracy on gender, immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), field of study (science + mathematics; engineering and a missing field dummy, compared to all other fields). Model 2 adds variables representing occupation ISEI score and industry sector. Models 3a-3c each build on Model 2, adding a variable representing occupation numeracy-intensiveness (coded so that higher values = lower numeracy-intensiveness) (3a); the lowest quartile of numeracy-intensiveness (3b), and the highest quartile of numeracy-intensiveness (3c). Coefficients which represent a statistically significant change from the previous models are highlighted in bold and grey.

In around a third of countries, the gender difference in numeracy among working adults is partially explained by individuals' occupational status and industry sector (Model 2). This is particularly notable in Norway and Sweden. In the latter country, the gap reduces by nearly 50 per cent when controlling for these job characteristics. Results from Model 3a suggest that occupation numeracy-intensiveness also plays an additional role in explaining women's disadvantage in numeracy in Denmark, France, Italy, and Japan. Its role is particularly important in Japan, where models 3a to 3c all show the gender difference in adult numeracy substantially reduced. In the other just mentioned, the gender difference, though reduced in comparison to Model 2, is at a similar or higher level to the original, raw gender difference (Model 0). Overall, there is no systematic evidence in favour of Hypothesis 2.

It is interesting to note that in the Netherlands, although gender segregation by numeracy-intensiveness was a notable phenomenon, this does not appear to contribute to explaining the gender difference in adult numeracy. On the other hand, the lack of explanatory role for occupation numeracy-intensiveness in the Czech Republic, Ireland, Poland, the Slovak Republic, and the USA is not at all surprising, considering that segregation by numeracy-intensiveness was not present in those countries. The lack of an additional explanatory role for numeracy-intensiveness in Sweden, Norway, Belgium, and the UK may be because the effects of numeracy-intensiveness are absorbed by the effects of the variables included in Model 2. Knowing that female-dominated, low numeracy occupations tend to be concentrated in particular industry sectors (i.e. the social services sector) helps explain these results. Moreover, having controlled for industry sector, it may be the case that occupation numeracy-intensiveness is actually lower among men than among women, so that a further explanatory effect on the gender gap in numeracy is not observable. It is possible that low numeracy intensiveness in combination with industry sector can partly explain the gender difference in adult numeracy in in Sweden, Norway, Belgium, and the UK.

Figure 5.4 shows the odds ratio from an equivalent sequence of models to those shown in Table 5.3, but this time predicting the probability of achieving low numeracy skills by gender (men compared to women). The results are displayed as odds ratios and all models control for a range of variables (see figure note).

Figure 5.4 Odds ratios (male) and 95% confidence intervals from logistic models predicting low numeracy levels, five specifications

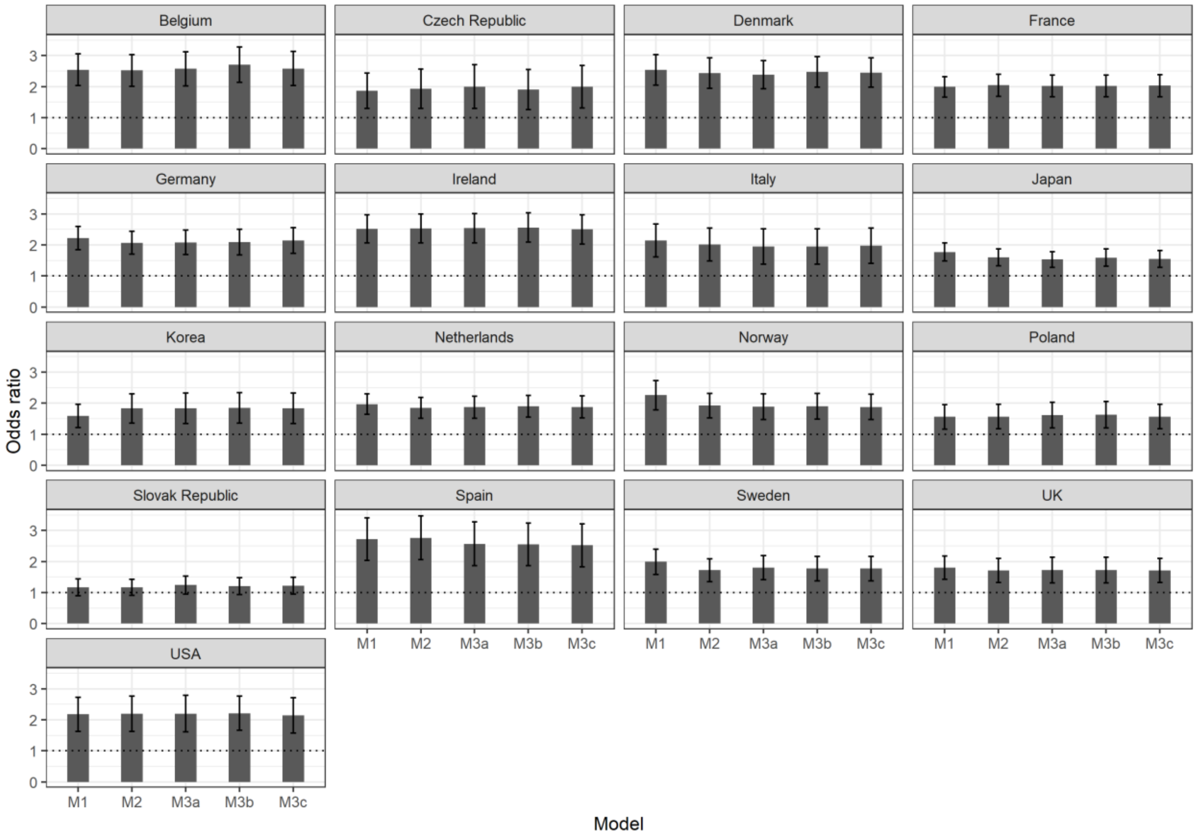


Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Odds ratios and significance levels reported in Appendix A5.6. Model 1 (M1) includes gender, immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), field of study (science + mathematics; engineering and a missing field dummy where necessary, compared to all other fields). Model 2 (M2) adds variables representing occupation ISEI score and industry sector. Models 3a-3c each build on Model 2, adding a variable representing occupation numeracy-intensiveness (coded so that higher values = lower numeracy-intensiveness) (3a); a dummy variable representing the lowest quartile of numeracy-intensiveness (3b), and a dummy variable representing the highest quartile of numeracy-intensiveness (3c). 'Low numeracy levels' = below 238 points.

In Belgium, Denmark, Norway, Sweden, and Japan, women's disproportionate likelihood of scoring at the lowest levels of numeracy reduces when controlling for sector of work and occupational status (Model 2). In Sweden, the female disadvantage virtually disappears. This is likely due to the particularly low numeracy intensiveness of the female-dominated services sector in these countries, demonstrated earlier. When adding variables representing occupational numeracy-intensiveness (Model 3a), a dummy variable representing the bottom quartile of numeracy-intensiveness (Model 3b) and a dummy variable representing the top quartile of numeracy-intensiveness (Model 3c), the female disadvantage does not further decrease. This suggests that in these countries, the gender segregation of industry sectors (with female-dominated sectors being characterised by low levels of numeracy-intensiveness) can partly explain women's over-representation at low levels of adult numeracy. In contrast, in Italy, the over-representation of women at the lowest numeracy levels *is* attenuated by accounting for occupation numeracy-intensiveness, suggesting that this type of segregation is an independent explanatory factor. However, in other countries – Spain, Ireland, Germany, and the Czech Republic – female over-representation at the lowest levels of adult numeracy remains substantial across all models, regardless of the job characteristics accounted for.

A similar picture is seen for the female under-representation at high levels of adult numeracy (Figure 5.5). When accounting for industry sector and occupational status (Model 2), the female disadvantage reduces in Denmark, Germany, Italy, Japan, the Netherlands, Norway, and Sweden. In Japan and Denmark, occupational numeracy-intensiveness of one's occupation also appears to play an additional role, over and above industry segregation. This may be explained by the male domination of numeracy-intensive occupations within the social services sector or within the private services sector, which was demonstrated by some of the example occupations in Table 5.1. In Spain, however, the female disadvantage in reaching high levels of numeracy was somewhat explained by numeracy-intensiveness of occupations, over and above industry sector and occupational status. This may be due to similar segregation processes occurring within sectors. However, it should also be noted that the female disadvantage in accessing the highest level of numeracy remains pronounced in most of the countries, even when controlling for the wide range of variables in these models. This is even the case in the Czech Republic and Poland, which, as we saw, showed almost no segregation in terms of numeracy-intensiveness. This suggests the importance of other processes occurring in the workplace, which may have not been captured by these models.

Figure 5.5 Odds ratios (male) and 95% confidence intervals from logistic models predicting high numeracy levels, five specifications



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Odds ratios and significance levels reported in Appendix A5.6. Model 1 (M1) includes gender, immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), field of study (science + mathematics; engineering and a missing field dummy where necessary, compared to all other fields). Model 2 (M2) adds variables representing occupation ISEI score and industry sector. Models 3a-3c each build on Model 2, adding a variable representing occupation numeracy-intensiveness (coded so that higher values = lower numeracy-intensiveness) (3a); a dummy variable representing the lowest quartile of numeracy-intensiveness (3b), and a dummy variable representing the highest quartile of numeracy-intensiveness (3c). 'High numeracy levels' = above 304 points.

5.8 Discussion

Women's participation in the paid labour force is generally considered to be a marker of gender equality and has many benefits for women's social and economic lives. Another benefit that is often assumed is to enable women to preserve and further develop skills. Indeed, previous studies have implied that once women participate fully in economic life, their skills will equalise with men's (e.g. Baker & Jones 1993; OECD 2013a). However, the evidence presented at the beginning of this chapter (Figure 5.1) shows that gender differences in adult numeracy are present even between men and women who are employed. To better understand the relationship between employment and gender differences in adult numeracy, this chapter developed and tested a new hypothesis, focusing not on men and women's rates of labour force participation, but on segregation within employment. The analysis focused on the use of numeracy skills in the workplace and how this may combine with and layer onto other axes of gender segregation in employment to affect women's relative levels of numeracy in adulthood. The chapter used a 'job skills' approach to derive an empirical measure of the numeracy-intensiveness of occupations, based on the Job Requirements Approach module of the PIAAC background questionnaires, wherein participants reported the extent to which they performed numerate tasks on a daily basis at work. This approach drew upon previous studies which have examined the characteristics and skill requirements of occupations as key to understanding gender segregation in the labour market (e.g. Kilbourne et al. 1994; Mandel 2016).

Unlike previous studies, which have emphasised the remarkable consistency of forms and patterns of gender segregation in the labour markets of industrialised countries (e.g. Charles 2011), this chapter identified distinctive patterns of gender segregation by numeracy-intensiveness across countries, therefore uncovering mixed support for the first hypothesis. The first notable pattern was the low numeracy-intensiveness of female-dominated occupations in the social services sector. However, while this was the case in all countries, the level of female employment in these low numeracy-intensiveness areas of the labour market was very variable. In the post-Soviet countries, particularly

Poland, more men than women are employed in low numeracy-intensiveness occupations (which are mainly routine manual occupations) and more women than men are employed in high numeracy occupations – directly contradicting the expectations of Hypothesis 1. This suggests that two variables are important for explaining whether segregation by numeracy-intensiveness will be present in a given country. If female employment in low numeracy-intensiveness, care occupations is high, gender segregation by numeracy-intensiveness will be relatively high. However, if male employment in manual, low numeracy occupations is high and there are more opportunities for women in high numeracy (generally private sector) employment, the level of gender segregation by numeracy-intensiveness is also high but reflecting this opposite pattern. This is well illustrated by the contrast between the Nordic and the post-Soviet countries.

However, in other countries, these patterns are less definitive, because women were shown to work in less numeracy-intensive occupations across the entire occupational spectrum, in a way that is more obviously linked to occupational status. For example, the pattern observed in Japan, Korea, Norway, the Netherlands, and Denmark seems to combine with vertical segregation, where male dominate analytical, high status, authoritative occupations (e.g. managers). Because men dominate the highest status occupations, their occupations are also higher in numeracy-intensiveness (since high status occupations are typically the most numeracy-intensive occupations available). Overall, this suggests that the extent to which women are more likely to work in occupations low in numeracy intensiveness (the first hypothesis, H1) is dependent both on country-specific patterns in the gender distribution of occupational status, as well as horizontal distinctions based on industry sector.

The low numeracy-intensiveness of female-dominated social services occupations adds an interesting variant to the broader discussion on gender segregation of employment. A large amount of scholarship has been dedicated to showing that female-dominated care work and routine, interactive service jobs are low in job quality, poorly rewarded, and devalued (e.g. Leidner 1991; England et al.

1994; England 2005; Hochschild 2012a). Meanwhile, the prevalence of these occupations is increasing in post-industrial societies, particularly among women (Webb 2009). This chapter provides more evidence that these occupations are low in inherent job quality – if we accept that skills use is an aspect of intrinsic job quality (Eurofound 2012; Green 2013). The findings are also congruent with previous evidence on the relatively low quality of female-dominated services employment, especially in the Nordic countries (e.g. Bihagen & Ohls 2007). This may represent a form of devaluation, whereby through employing mainly women, these jobs are not valued to the same extent as male-dominated jobs at a similar skill level. Indeed, we see that several manual male-dominated occupations typically classed as 'low skilled', in fact have relatively high levels of numeracy-intensiveness (e.g. metal workers). However, any discussion on the qualities of care occupations must also consider the implicit gendered valuation processes involved in characterising occupations. Many care and social services occupations in fact use complex skills, just not those that are typically valued by the market (although there is some evidence that this may be changing as complex social skills gain more economic value (Cortes et al. 2018)). Nonetheless, using cognitive skills does constitute an aspect of intrinsic job quality, which in turn impacts on broader quality of life (Drobnič et al. 2010). Therefore, women's concentration in low numeracy-intensive occupations should be taken seriously.

The post-Soviet countries displayed very distinctive results regarding the gender segregation of occupational numeracy-intensiveness. Although post-Soviet labour markets are still gender-segregated, with women predominant in care occupations and men in manual ones, women are well-represented in jobs that use numeracy, such in finance and business services. Interestingly, the occupations that are high in numeracy-intensiveness are mainly found in the private services sector and would not have been present under state socialism. This suggests that the transition to capitalism may have created new forms of employment for women, in spite of the manual/non-manual divide remaining in place (Pollert 1995, 2005). These findings may also be related the history of women's employment in post-Soviet countries. Under socialism, women had a strong presence in roles requiring numeracy: for example, trading in the informal economy, accounting and clerical roles in state employment, and medical occupations (Gal and Kligman 2000). Contrasts across societies in this alternative form of segregation therefore cannot be easily summarised by traditional indicators of segregation or by ‘gender essentialist’ ideas about the assertion of gendered affinities. Moreover, it should be noted that in all countries, some women work in numeracy-intensive occupations, though these tend to be more routine jobs than the numeracy-intensive occupations held by men.

This cross-country variation shows that occupational segregation can have a very different character depending on the nation considered. This aspect of variation between countries is taken forward into the next chapter, which explores whether it is an important aspect of country context that explains the gender difference in adult numeracy. In particular, it is suggested that the level of female employment within occupations low in numeracy-intensiveness will be important.

To some extent, low numeracy-intensiveness is a characteristic of both male and female employment. However, in several countries, particularly France, Denmark, Sweden, and Norway, it appears to be strongly associated with female-dominated employment in the social services sector. In these countries, women’s disproportionate employment in these sectors could partly explain gender differences in adult numeracy. In France, Denmark, Italy, and Japan, low numeracy-intensiveness was not only aligned with the typically female sectors of employment; it also provided an independent explanation of gender differences in adult numeracy, providing some evidence in favour of Hypothesis 1 This suggests that, in these countries, numeracy-intensiveness is a dimension of gender segregation that cuts across industry sector and occupational status, and has an independent influence on men and women’s relative levels of adult numeracy. However, hypothesis 1 was not uniformly supported; it is therefore not possible to conclude from these findings that the gender segregation of occupational numeracy intensiveness is a major determinant of gender differences in adult numeracy.

Notwithstanding the mixed results, exploring gender segregation by numeracy-intensiveness achieves two goals: firstly, it adds further detail to our understanding of the characteristics of female-dominated and male-dominated occupations and industry sectors. Secondly, it adds another dimension to the analysis of the gender segregation of employment, showing notable cross-country variation in the way labour markets are structured. This type of segregation may be important to consider in its own right alongside more traditional indices of segregation such as those relating to standalone occupations or industry classifications, or occupational status. Moreover, the numeracy-intensiveness of occupations is one factor explaining the gender difference in adult numeracy, particularly in the Nordic countries and in Japan. These results are indicative of complex patterns of segregation which go beyond designations of 'vertical' and 'horizontal' and may represent variant logics of segregation. This suggests that variants of masculinity and their influence on the labour market are highly contextually specific and reflected in patterns of skills use in occupations.

There are several limitations to the analysis presented in this chapter. Firstly, the chapter used a sub-sample of employed adults. There are marked variations across countries in the characteristics of men and women who participate in paid labour (particularly among women). For example, female labour force participation is associated with education, number of children, and other factors, which vary across countries according to social policies and culture (e.g. Misra et al. 2007; Boeckmann et al. 2015). Therefore, the selected samples, although they are representative of working adults, comprise a selective group of women. Figure 5.1 showed that adult numeracy is particularly low among women who are out of the labour force; the explanations for this have not been considered in this chapter, though it seems to suggest either that women who enter the paid labour force have higher levels of numeracy than those who do not, or that participating in paid employment is beneficial for adult numeracy.

The second limitation relates to the analysis of occupations. The occupations represented in each countries' samples (with more than ten employees) were used to analyse median skills use within occupations. However, the occupations represented within each country's PIAAC sample may not be representative of a full range of occupations, and the occupations represented may vary across countries. There is some uniformity in the occupations which are represented, but some differences too. To some extent, this will reflect genuine differences across countries in the character of employment, but it may also be a product of sampling variation. Occupations were also analysed at different levels of aggregation. To obtain sufficiently large cell sizes, three-digit ISCO occupation codes were used. However, in some countries (the USA, Sweden, and Ireland), three-digit codes were not available, and two-digit codes were used instead. Therefore, occupations are compared at different levels of detail. The impact this may have on results is not quantifiable without alternative sources of occupational data for the same sample, which are not available.

Furthermore, the skills use measures are derived from self-report, and only measure a subset of numeracy skills that one could possibly use at work. There may also be a relationship between gender and measurement error on this variable. Job evaluation involves value judgement, and the skills perceived and reported as associated with a particular job might be influenced by gender. For example, a study by Horrell et al. (1990) noted that men were more likely to perceive their jobs as skilled than women. If men systematically over-report the extent to which they use numeracy at work, this could be reflected in the results. Moreover, psychological factors such as maths anxiety may prevent women both from using numeracy at work or from reporting that they do so (Jansen et al. 2016). In order to check for the presence of under- or over-reporting, a validation study would be required whereby the self-reports were cross-checked with employer reports or official, detailed job descriptions; notwithstanding the checks for measurement invariance carried out by the OECD (2013b). However, bearing all this in mind, it should also be noted that PIAAC is the best source of data available on 'job skills' internationally (Felstead et al. 2017).

Although causal inference is not possible using these data, I have developed a narrative implying that the characteristics of occupations influence skills rather than the other way around. I have constructed this narrative based on arguments from the literature on the determinants of skills proficiency among adults and cognitive ageing. However, it is also plausible that individuals select into occupations whose numeracy-intensity profile matches their existing proficiency (Speer 2017). Therefore, any associations between adult numeracy and occupational numeracy-intensiveness could reflect such a selection effect. Moreover, previous research has suggested that individuals' skills are often 'mismatched' with the characteristics of their occupation (De Grip & Van Loo 2002; Quintini 2014). However, since no strong evidence was found in favour of Hypothesis 2, these considerations are less urgent.

5.9 Conclusion

In conclusion, this chapter went beyond the idea that female empowerment though employment reduces gender differences in adult numeracy, instead exploring gender segregation in employment as a key explanatory factor. The chapter identified that gender segregation by numeracy-intensiveness is a feature of a number of labour markets. It therefore illustrated that applying a job skills approach can illuminate previously overlooked aspects of gender segregation in employment. In relation to the overall aims of the thesis, the results of this chapter suggest that the qualities of female and male employment are important for explaining why men tend to outperform women in adult numeracy in some countries. In Japan, Korea, France, and Sweden, the gender difference in adult numeracy is much reduced from the initial gaps observed in Chapter 3 when accounting for gender segregation in employment, particularly when considering industry sector. This suggests that enabling women's employment via policy measures such as providing childcare and flexible working provision (see OECD 2013a), are unlikely to be the only relevant strategies for reducing gender differences in skills, since it appears that the characteristics of women's jobs are also important for explaining their relative skill levels.

However, gender differences still remain at the individual level when accounting for work-related variables, showing that these provide only a partial explanation. This suggests that gender differences in adult numeracy are not only explained by the observed individual-level variables and could therefore be the result of either unobserved individual-level variables or macro-level conditions. Chapter 6 moves to the level of country contexts to explore the role of macro-level factors that operate over and above individual-level variables.

6. Gender relations and the gender difference in adult numeracy

6.1 Introduction

While a male advantage in adult numeracy is widespread, gender differences vary across countries. For example, the raw gender difference among the full adult sample ranges from an effect size of 0.04 in the Slovak Republic to 0.35 in the Netherlands. The gender difference in the other samples considered (25–34–year-olds, 55–64–year-olds and working adults aged 16–65) shows similar levels of cross-national variability, retained even when controlling for a range of individual-level variables. This cross-national variability is congruent with previous research on the relationship between gender and numeracy (Guiso et al. 2008; Penner & Paret 2008). It is also crucial to a social constructionist framing of gender differences in skills. As described in the introduction, well-known scholars promote the idea that gender differences in cognitive skills are the result of biological or evolutionary differences between men and women (Kimura 1996; Baron-Cohen 2004). Innate gender differences could plausibly generate a gender difference in numeracy skills but could not explain why this varies across countries (Penner 2008; Bedard & Cho 2010). It is therefore important to understand whether, and in what ways, social context influences how gender differences are realised in different countries, over and above any biological predispositions and individual experiences.

While variability in social outcomes can be explained with reference to numerous levels of social context, including micro-, meso-, and macro-levels (Goldthorpe 2016), scholars who study gender differences and inequalities are often keen to stress the importance of structural features of nation-states as a critical frame for gendered outcomes among citizens of those contexts, particularly in the realms of education and work. For example, features of national context have been shown to be important for explaining international variation in a range of gendered outcomes, including female employment rates (Thévenon 2016), gender gaps in STEM-related attitudes and educational expectations (McDaniel 2016), and gender gaps in adolescent mathematical skills (e.g. Penner 2008). Focusing on associations between features of national context and gendered outcomes provides a way to contextualise differences, demonstrate that variation is systematic rather than random, and emphasise that altering individual men and women's circumstances may often not be enough to bring about changes in the outcome in question. For example, Fuwa (2004) stresses that, notwithstanding changes in individual men and women's circumstances, only the reduction of 'macro-level gender inequality' will result in the equal division of housework. Studying social context also supports the broader argument that gender differences in adult numeracy may be reduced by altering aspects of social policy and public life that shape gender relations, either through direct intervention or via more organic change over time.

National context may be even more important than individual characteristics for explaining gender differences in numeracy and related skills. There are relatively few existing studies that examine both individual-level and societal-level explanations for gender differences in numeracy skills (although see Dickerson et al. 2015; Gevrek et al. 2018). However, in one of the few studies that took this approach (Dickerson et al. 2015), researchers compared the salience of a range of individual factors, including parental investments in schooling and a range of school-level factors, and found these to be far less important than features of national context. These features included fertility rates and rates of female education, which were hypothesised to represent levels of female empowerment and cultural values. While Dickerson et al.'s study could not distinguish precise mechanisms, the results suggest that variation between societies may be more important than variation between individuals for explaining the gender difference in numeracy and related skills. The results of the thesis so far suggest that in the case of adult numeracy, individual-level characteristics can explain a portion of the gender difference in certain countries and age groups, but significant and in some cases large gender differences remain when controlling for individual characteristics.

This chapter follows the general approach of previous studies (Baker & Jones 1993; Riegle-Crumb 2005; Guiso et al. 2008; Penner 2008; Else-Quest et al. 2010; Gevrek et al. 2018) by focusing on aspects of gender difference and inequality at the country level as the most likely country-level predictors of gender differences in adult numeracy. However, this chapter's approach differs from that of previous research by seeking to account for cross-national variation in gender differences in adult numeracy in terms of countries' *gender relations*, rather than *gender inequality*. In doing so, it seeks to provide answers to the thesis' third research question – how are gender differences in adult numeracy related to societal-level gender relations? I suggest that arguments put forward in previous literature, which propose that gender differences in adult numeracy are related to 'gender inequality', are likely to be too simplistic, which may explain their inconsistent empirical support. Following the feminist, sociological literature on gender relations (e.g. Connell 1987; Pfau-Effinger 1998), country-level configurations of gender relations are conceptualised along three main axes, which are operationalised using country-level data from various secondary sources. These axes are: the gender division of power, the gender division of labour, and gender culture.

This chapter uses a range of different indicators of gender relations and applies the technique of cluster analysis to examine how these indicators manifest in the countries under study. Creating groupings of countries on this basis, rather than focusing on 'levels' or degrees of inequality, this chapter foregrounds the varied ways in which societies configure relations between men and women. Conceptualising and measuring gender relations in this way recognises not only that societies have 'different ways of structuring gender, reflecting the dominance of different social interests' (Connell 1987: 63), but also that societies can exhibit egalitarian and inegalitarian features simultaneously (Mandel 2009) and subscribe to different definitions, emphases, and policy solutions when it comes to the complex issue of gender inequality (Pascall & Lewis 2004; Verloo 2007).

6.2 Chapter outline

The following section, 6.3, reviews the way in which 'gender inequality' has been operationalised in previous cross-national studies of gender differences in numeracy and related skills. I highlight some of the problems in this literature, before suggesting that studying gender relations as a configuration is a preferable approach to understanding how national context influences variation in the gender difference in adult numeracy. In section 6.4, I describe the aspects of gender relations that are operationalised in this study and hypothesise as to how they may be related to gender differences in adult numeracy. The methodology is then described in section 6.5, results are presented in section 6.6, and an interpretation and conclusions are offered in sections 6.7 and 6.8.

6.3 The gender stratification hypothesis (revisited)

Recent years have witnessed a growth in cross-national studies of numeracy and related skills, exploring the idea that gender differences in these skills could be related to gender (in)equality at the national or macro-level. On the whole, this literature has focused on linking male advantages in adolescent mathematics achievement to gender inequality in access to education, the labour market and positions of power in society, often measured by composite indicators such as the Gender Empowerment Measure (GEM) and Gender Gap Index (GGI). Studies thus aim to provide empirical verification of the 'gender stratification hypothesis' (Baker & Jones 1993). This hypothesis suggests that the male advantage in mathematics achievement is a product of male advantages in education, the labour market, and in society as a whole. This leads to the prediction that the male advantage should decline where gender parity in these areas is achieved. There is some support for this prediction, as described in Chapter 1 (Baker & Jones 1993; Riegle-Crumb 2005; Brody & Mills 2005; Guiso et al. 2008; Hyde et al. 2008; Wai et al. 2010; Else-Quest et al. 2010; Kane & Mertz 2012; Rodríguez-Planas & Nollenberger 2018; Gevrek et al. 2018).

Under equality, it is argued in these studies, women gain more access to opportunities to develop and maintain skills and receive signals from the social environment that varied economic roles, including roles requiring numeracy skills, are possible for them. For example, Gevrek et al.'s 2018 study claims that 'policy initiatives aiming at bolstering female empowerment could serve as powerful tools to improve girls' mathematics achievement' (Gevrek et al. 2018: 20). There are certain problems with this idea, which I now describe.

Firstly, despite the bold claims of some studies, taking the literature as a whole, the gender stratification hypothesis is not well supported. For example, recent studies have shown that gender differences in mathematical skills remain substantial in supposedly 'egalitarian' countries, which are characterised by high female labour force participation rates and smaller gender wage gaps. For example, analysis of PISA 2012 data shows that gender differences in mathematics achievement among 15-year-olds are still pronounced in countries that are widely considered to be relatively egalitarian, such as Denmark, the UK, and Australia (OECD 2015). The previous chapters in this thesis have shown differences are prominent in similarly egalitarian-seeming countries, including Denmark, Norway, and Sweden. Moreover, some recent studies have found no evidence of any relationship between national-level gender equality and gender differences in mathematics or other STEM-related outcomes (Fryer & Levitt 2010; Stoet & Geary 2015; Ireson 2017; Tao & Michalopoulos 2018). This is particularly the case in studies incorporating Gulf countries, such as Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia. Here, in countries with high levels of gender inequality, gender differences in adolescents' mathematics achievement are comparatively small, contradicting the predictions of the gender stratification hypothesis (Fryer & Levitt 2010; Ellison & Swanson 2010). Paradoxically, there may even be a positive relationship between gender equality and the gender difference in numeracy. For example, Penner (2008) finds a larger male advantage in mathematics achievement in countries with relatively high levels of female labour force participation, a key indicator of gender equality and female empowerment.

These inconsistent findings have led researchers to argue that alternative, more conceptually advanced models are needed to explain cross-national differences in STEM-related aptitudes (Stoet et al. 2016). The counter-evidence suggests that either (a) that gender inequality is not being measured in a way that it actually relevant to explaining gender differences in numeracy and related skills or (b) the relationship is not so straightforward as ‘gender equality reduces gender differences in numeracy’, or both. I address these issues in turn.

A number of ‘gender stratification’ studies have used composite indices of gender inequality to characterise countries and make comparisons between them. These indices are constructed using multivariate techniques such as Principal Components Analysis, to combine multiple aspects of gender inequality into one continuous measure, where higher scores signify more equality (and vice versa). In theory, such a measure is preferable to using single indicators of gender inequality. For example, a widely cited study by Guiso and colleagues (2008) uses a composite measure combining female ‘empowerment’ (summarising women’s economic opportunities, economic participation, educational attainment, political achievements, and health and wellbeing), as well as measures of attitudes towards the role of women in society, female economic activity rates and measures of female participation in decision-making at the legislative level.

Although Guiso et al.’s study uses an impressive range of indicators from a variety of sources, most of the indicators are focused on women’s status or ‘emancipation’ within public life. Moreover, typically only the first principal component is used to create a single, linear measure, neglecting other possibly important aspects of variation between countries. Their measure reflects important differences between countries in terms of women’s relative status and opportunities. However, the measurement of gender inequality at the national level is a fraught and problematic area, with many possible choices about what to include (Young et al. 1994; Moghadam & Senftova 2005; Else-Quest & Grabe 2012). Using a univariate indicator presents a limited view of contextual gender relations, suggesting that gender equality has been ‘achieved’ when scores are high, usually in the context of economic modernisation, which draws women into the paid workforce, produces more egalitarian norms, and undermines traditional images of women’s caregiving role (Inglehart & Norris 2003). Yet, this view of gender inequality as incremental, evolutionary change is limited, since it does not consider persistent forms of gender segregation and the domain-specificity of women's gains. Instead, multidimensional understandings of gender relations are needed, especially in a comparative context (Walby 2004; Verloo 2007; Charles 2011). Moreover, a full understanding of the relationship between various aspects of gender relations and the gender difference in numeracy requires engagement with 'outlier countries' or apparently contradictory results, rather than an automatic assumption that all forms of equality and emancipation will naturally decrease skills gaps between men and women, and the suppression of cases that do not fit this narrative. Methodological studies have also questioned the validity of using unidimensional, composite measures of gender inequality to rank countries (Constantin & Voicu 2015).

Therefore, with their focus on mainstream indicators of women's empowerment and participation in society's institutions, and lack of adequate theorisation as to why these indicators should be relevant to cognitive skills at all, studies like Guiso et al.'s deflect from broader structures of inequality which may cause women's enduring disadvantage in numeracy skills, even in supposedly 'equal' countries. In the following section, I describe an alternative framework which aims to correct some of the deficiencies of existing studies and can be used to challenge the assertion that gender equality reduces gender differences in numeracy.

6.4 Configurations of gender relations

The analysis in this chapter is based on a new framework, which uses the insights of previous studies on factors that are central to the relationship between gender inequality and gender differences in numeracy skills, as well as adding new insights into this relationship. Four groups of indicators are considered. These are the *gender division of power*; the *gender division of paid* labour, including conventional indicators of segregation as well as indicators derived in Chapter 5 relating to the numeracy-intensiveness of female employment; and *gender culture.* The analysis also adds another indicator that has not been previously considered in this context but is an important aspect of gender relations: *the gender division of unpaid labour*.

6.4.1 Why study gender relations as a configuration?

A number of sociological studies have now questioned the idea that post-industrial societies in North America and Europe have achieved gender equality by drawing attention to the persistent segregation and discrimination that is evident alongside women's empowerment (England 2010; Charles 2011; Scott et al. 2010). Alongside this, there is evidence of complex gender role attitudes in the populations of supposedly egalitarian societies, which are not always supportive of women's equal status or may illustrate a backlash against women's gains (Scott et al. 2008; Braun & Scott 2009; Aboim 2010; Knight & Brinton 2017). This unevenness, complexity, and fluctuating nature of 'gender inequality' suggests that relations between the genders are more appropriately viewed as a configuration, with various conflicting and contradictory aspects (Connell 1987; Fraser 1994; Pfau-Effinger 1998; Chang 2000; Mandel 2009).

Although a focus on independently varying structures of 'horizontal' and 'vertical' gender inequality has become popular in the past couple of decades, the idea that gender inequality is composed of separate and independently varying structures, which combine in complex configurations, goes at least as far back as 1978, when Whyte suggested that there were nine empirically verifiable dimensions of gender inequality (Whyte 1978). Various subsequent publications theorised the multidimensionality of gender inequality in greater depth (Lorber 1994; Young et al. 1994; Pfau-Effinger 1998; Walby 2004; Moghadam & Senftova 2005). In *Gender and Power* (1987), Raewyn Connell coined the term 'gender relations' and proposed three independently varying structures: the division of labour (including the gender division of both unpaid and paid labour); the division of power (authority, control, and coercion); and cathexis, constraints on interpersonal and emotional relationships[24]. On each dimension, one can trace examples within institutions, the family, culture, and workplaces. Complex configurations of gender relations at the national level are thought to emerge not only from the accumulation of everyday enactments of gendered behaviour (Connell 1987; Martin 2004), but also from state-level enactments of gender equality policies (Pascall & Lewis 2004; Verloo 2007) and underlying cultural logics (Pfau-Effinger 2005), which support certain versions of equality while overlooking others. This creates gender equality 'trade-offs' (Mandel 2009), which have been noted within scholarship on the gendered impact of welfare states (e.g. O'Connor 1993; Pascall & Lewis 2004). Instead of some societies being 'egalitarian' while others are 'traditional', aspects of both are combined in complex ways, especially when one considers state policies, gender segregation, and gender role attitudes as important aspects of gender relations, alongside women's empowerment (Mandel 2009; Knight & Brinton 2017)[25].

These considerations suggest that to gain a full understanding of the way gender is structured at the societal level, it is necessary to add further indicators to those that are conventionally included in gender equality indices. While a great variety of such supplementary indicators have been suggested, the general tenor of these suggestions is that we need indicators pertaining to relations in the workplace, the domestic sphere, and culture. It is also necessary to analyse these indicators using multivariate methods that can reveal their multidimensionality. A multidimensional analysis may illuminate the apparent 'paradox' characterising the relationship between gender inequality and gender differences in numeracy and related skills (Stoet & Geary 2018).

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[24] Further discussion of gender relations can be found in Chapter 1.

[25] It is important to note that there are different interpretations of the multidimensional nature of gender relations. Some argue that full equality has not yet been achieved due to persistent discrimination, segregation, and the persistence or resurgence of traditional cultural attitudes towards gender (the idea of a 'stalled gender revolution' – see England (2010); Cotter et al. (2011)). Others argue that the general trend is towards equality, but there are time lags whereby attitudes and behaviour are caught in a process of 'lagged generational change' (Sullivan et al. 2018; Inglehart et al. 2017)

The next section describes the indicators that are used to operationalise gender relations, developing expectations regarding how each dimension may be related to the gender difference in adult numeracy.

6.4.2 The gender division of power

The indicators in this group are gender differences in years of education, the level of female labour force participation, and the gender wage gap. These are the types of indicators that have been the main focus of previous research and continue to be central to public debates on gender inequality. As such, they are key components of indicators such as the GEM and the GGI (Else-Quest & Grabe 2012). For many feminist researchers and thinkers, education, income, and work are the main ways people achieve social status, economic independence, and self-actualisation in modern societies; equal involvement in these domains is therefore a central goal of feminist activism (Blumberg 1984; Orloff 1993; Fraser 1994; Mandel 2009). According to this understanding of gender equality, this set of indicators constitute central pillars of gender relations. Moreover, these indicators still show considerable variation across industrialised societies (e.g. Thévenon 2016).

A further indicator is added to this aspect of gender relations, which provides an indication of female participation in decision-making at the national level. While not obviously related to skill development in the way that employment and education are, the representation of women in parliament represents not only the extent to which women participate in high status and demanding jobs, but also the degree to which women's interests are likely to be prioritised in decision-making (Wängnerud 2009). Moreover, the degree to which women are represented in politics is often widely known about and thus represents a socially patterned, institutionalized marker of women's status, potentially reflecting overall attitudes towards gender equality (Goffman 1977).

Previous studies on the relationship between gender inequality and the gender difference in numeracy have taken these indicators as central and suggested that access to education and the labour market should be related to the gender difference in numeracy skills, because these variables indicate the level of economic opportunity and power available to women. A labour market with visible female presence, it is argued, increases girls' motivation to acquire numeracy skills (Baker & Jones 1993), which are marketable skills, strongly associated with good positions in the labour market (Sells 1978). The 'opportunity structure' for women shapes the incentives for girls to acquire numeracy skills and therefore the gender gap in numeracy skills. This argument is essentially one of rational choice, whereby when there are more opportunities for women to exercise and benefit from numeracy skills, they will be more likely to obtain and maintain these skills, and the gender difference in numeracy will be smaller.

While a distinction can clearly be made in that societies where women have low levels of power will offer little opportunity for women, and little motivation or arena in which to develop numeracy skills, the relationship between the gender division of power and gender differences in numeracy is not necessarily straightforward when considering post-industrialised countries in which women have achieved a certain level of economic empowerment. Despite their importance of equality of educational access and labour force participation for the ability to obtain and maintain important and marketable skills, relative equality in these domains may exist alongside deep and enduring segregation. The combination of an enlarged female labour force and changes in labour market composition have led to more diverse work opportunities for women, including the incorporation of traditional household tasks into paid work (Charles 1992; Esping-Andersen 1999; Charles & Grusky 2004). Working in these feminised jobs does not necessarily increase women's economic power, competitiveness, or opportunities, and may not offer sufficient motivation for the development and maintenance of numeracy skills. It is therefore necessary to also consider the division of labour, particularly the division of paid labour in the market, and the responsibility for unpaid labour in the home. These indicators, and their hypothesised relationships with gender differences in numeracy, are described next.

6.4.3 The gender division of paid labour

As discussed in the previous chapter, the segregation of jobs and workplaces is a major structure of gender relations in industrialised societies. Feminised jobs are often associated with serving and caring, whereas men's jobs are associated with physical strength and power (Anker et al. 2003; Charles 2005). Women are over-represented in the service industries, particularly in clerical work, cleaning, food service, teaching, and nursing. Men are over-represented in management, the financial sector, legal and technical jobs, as well as jobs that require manual labour (Charles 2011). Occupational segregation along these lines is pronounced across the industrialised world and has changed relatively little over the past few decades (Charles 2011).

How might the gender division of paid labour affect gender differences in adult numeracy skills? There are two potential mechanisms. These mechanisms represent the tension in the literature between culturalist and structuralist interpretations of gender divisions in post-industrial societies. On the one hand, segregation could contribute to the creation and perpetuation of gender norms (Eagly & Wood 1999; Eagly et al. 2000). According to Charles and Grusky (2004), gender segregation in the labour market is both a consequence and a driver of 'gender essentialism', creating standards of femininity and masculinity which people feel they must adhere to (Charles 2011). According to both role theory (Turner 1956) and the social psychology of gendered behaviour (Eagly et al. 2000; Eagly & Wood 1999), individuals acquire norms, attitudes, and role behaviours through interactions with significant others and the observations of reference groups. If women's reference group, i.e. other women, occupies high status roles in the labour market that involve numeracy, the expectation that women will develop and maintain adult numeracy is likely to be higher. Thus, in order to conform to role expectations, women will be incentivised to maintain and develop numeracy skills to a greater extent and to develop related, gender-congruent career aspirations (Xie & Shauman 1997). Reflecting the gendered division of labour in their choices and behaviours may also be one way of 'doing gender' (West & Zimmerman 1987), argued to be an important aspect of self-expression in contemporary societies.

On the other hand, gender segregation in the labour market can be viewed as an institutional constraint, actively preventing women from obtaining and maintaining adult numeracy skills, regardless of their individual, conscious or unconscious, preferences. This view is in line with another strand of literature which focuses on institutional constraints as the main driver of gender differences in education and work domains (e.g. Reskin & Roos 1990; Reskin & Maroto 2011; Pedulla & Thébaud 2015). Indeed, according to Pearse and Connell (2016), the skills and aptitudes are appropriate for men and women to acquire are reproduced by the routine functioning of institutions. For example, even where there is a strong public culture of gender equality and equal opportunities, the structure of institutions can reproduce segregation, through mechanisms such as hiring practices, men actively preventing women from entering certain fields, and discrimination, both overt and covert (Weeden & Sorensen 2004; Scott et al. 2008; Reskin & Maroto 2011). For example, women may be forced into lower skilled or more ‘female-typical’ work by discrimination in hiring and human resources practices (Petersen & Saporta 2004; Reskin & Maroto 2011). The gender segregation of occupations can also be seen as a form of class inequality between men and women (Crompton & Mann 1986), wherein certain privileged, skilled positions are closed to women. The growth of female niches within the economy may also discourage women from developing and maintaining numeracy skills which are more applicable to male-dominated sectors. Gender segregation in the labour market could therefore provide a ‘powerful social constraint’ (Connell 1987: 100) informing gendered patterns of skill development.

The analysis presented in the previous chapter identified a particular form of occupational gender segregation associated with the degree to which women participate in occupations that involve using numeracy skills. Where this form of segregation is pronounced at the country level, this may intensify the processes highlighted above by increasing the number of women working in areas that are not beneficial to adult numeracy, and, conversely, increasing opportunities for men to participate in numeracy-intensive areas of work.

6.4.4 The gender division of unpaid labour

The confinement of women to the domestic sphere throughout history and in some contemporary societies is an obvious instance of women's dependency on men and low social status (Chafetz 1988). In such a context, women would be constrained from developing and maintaining numeracy skills in their adult lives, even if individually, they were well educated. However, even in industrialised societies where many women are well educated and participate in the labour force, women's disproportionate responsibility for unpaid labour such as housework and care for dependents continues and is cited as a key indicator of the 'stalled' gender revolution (Breen & Cooke 2005; Crompton et al. 2005; Hook 2010; Hochschild 2012b;). Moreover, the gender division of time spent on household labour still shows considerable variation cross-nationally, even between countries that have similar levels of equality in other areas (Altintas & Sullivan 2016).

Women's heightened responsibility for domestic labour could be one societal-level factor driving gender differences in adult numeracy, preventing women from developing and maintaining numeracy through constraints on their time, energy, and resources to do so, and contributing to a social environment in which women's time, labour power and thus skill development are less valued. Importantly, these effects may operate independently of other aspects of gender relations. So, a hypothetical configuration could be one in which women have a degree of economic power through their participation in education and the labour market but are constrained in their ability to develop numeracy skills through heightened responsibility for domestic labour. Moreover, the gender division of domestic labour could contribute, at the societal level, to norms surrounding the ideal social and economic roles of men and women. Although we also measure attitudes in this domain, it is important to note that attitudes and behaviour on domestic labour often do not align (Aboim 2010). Therefore, this measure of actual behaviour in the domestic sphere may represent an aspect of gender relations that varies independently from other gender role attitudes.

6.4.5 Gender culture

Up to now, I have stressed the importance of social institutions, particularly the labour market and domestic sphere, in the definition and comparison of gender relations in different societies. However, as Pfau-Effinger (1998) highlights, gender relations are also structured by cultural values and ideals held by individuals within a society. These can be measured at the national level and viewed as a feature of collective life (Pearse & Connell 2016).

While often referred to as a singular concept, ranging from 'traditional' to 'egalitarian', 'gender culture', usually operationalised as population-level gender role attitudes, can be conceptually and empirically distinguished into different dimensions, which reflect various strands of beliefs about responsibilities for work and family and the qualities of masculinity and femininity (Pfau-Effinger 1998; Knight & Brinton 2017). Most commonly studied are beliefs about egalitarianism in the labour force – the primacy of men in the economy, and the importance of employment for women[26]. Male primacy refers to the idea that men are more powerful and autonomous than women, are better suited to breadwinning, and therefore should be prioritised in the economic sphere. Male primacy may also be connected to a belief that men are more suited to numerate activities. For example, the field of gender, science and technology studies has highlighted the symbolic association between male power and science, technology, and mathematics, which operates through the 'mastery of nature' and the masculinisation of technological and analytical expertise (Cockburn 1981; Wajcman 1991, 2009; Cockburn & Ormrod 1993; Bray 2007; Faulkner 2007). Thus, support for male primacy could reference

[26] The indicators in this chapter focus on this strand of gender role attitudes. Another important dimension, described by Knight and Brinton (2017), relates to 'women's essential nature as wives and mothers', which can be measured by a separate set of indicators. This dimension has not been considered due to data limitations (the relevant indicators were not available for all the countries under study) but is potentially an important aspect of gender culture to consider in relation to gender differences in adult numeracy.

a broader culture in which male power and male domination of technical and scientific fields are intimately connected in the public consciousness.

Support for women's employment represents another aspect of egalitarianism in the labour force. Where women are primarily seen as carers and potential additional earners, i.e. their employment is not valued or important, there may be more incentive for women to choose jobs that are less career-oriented, more flexible, and thus more 'typically female' in their tasks and requirements. This may affect women's ability to acquire and maintain numeracy skills across their adult lives. Moreover, the importance attributed to women's employment could influence individuals' educational expectations, ambitions (McDaniel 2010), and skill investment strategies. For example, women who do not expect to be responsible for breadwinning themselves, due to a belief that women's careers are less important, do not need to maximise their returns on the labour market by developing important, marketable skills such as numeracy (Salikutluk & Heyne 2017). More widespread beliefs in the low value of women's employment could therefore increase males' performance in numeracy and lead to larger gender differences in numeracy in adulthood.

There are wide variations across industrialised societies in the extent to which people support the traditionally gendered division of paid labour, which do not always match up with social realities: countries can combine trends such as high female labour force participation with more 'traditional' attitudes, and vice versa (Alwin et al. 1992; Haller & Hoellinger 1994; Aboim 2010). This may reflect what scholars have referred to as a 'time lag' between the improvement of women's economic position and the widespread adoption of more egalitarian gender norms (Seguino 2007; Inglehart et al. 2017; Sullivan et al. 2018). Alternatively, support for more 'progressive' values may be highly domain-specific and complex, and national gender cultures may combine both elements of traditionalism, and elements of egalitarianism (Cotter et al. 2011; Knight & Brinton 2017). For example, it is possible for attitudes to encompass both support for male primacy in the labour market *and* a belief that women's employment is important. These views may or may not be reflected or reinforced by more concrete indicators of women's economic position.

Beyond rational responses to perceived barriers, gender cultures devalue women's work may also structure individuals' acquisition of gender role behaviours. According to role theory, as described above, gender role expectations or norms, present in the wider culture, and internalised through various mechanisms such as the media, education, parents, and teachers, define which actions are appropriate to each gender, including skill development (e.g. West & Zimmerman 1987). Previous research at the regional level in the United States suggests that the presence and absence of widely endorsed stereotypical gender norms is related to stereotypically gendered performance on skills tests (Pope & Sydnor 2010), while experimental studies show similarly powerful effects when test-takers are primed with stereotypical gender norms (Spencer et al. 1999).

6.5 Methodology

The analysis for this chapter proceeds in four stages. The first stage consists of generating the clusters of countries based on the various indicators of gender relations at the national level. The second stage consists of describing those clusters in terms of their values of the various country-level indicators. Next, I compare the clusters in terms of their average values of the gender difference in adult numeracy. Finally, a series of two-step models are constructed to assess whether cluster membership and individual indicators of gender relations are related to the unexplained portion of the gender differences in adult numeracy in three analytical samples, derived from the previous chapters.

Cluster analysis

Rather than analysing whether societies are that are 'more equal' have a lower gender difference in adult numeracy, the analysis focuses on whether particular configurations of gender relations are associated with higher or lower gender differences in adult numeracy. The goal is to identify clusters of countries which can be characterised in terms of their particular configuration of gender relations. This calls for an exploratory, multivariate approach. Exploratory multivariate approaches similar to the one used in this chapter have been used to study gender relations in previous publications, such as Mandel (2009) and Steinmetz (2012).

Cluster analysis is a descriptive method which classifies cases into *maximally homogenous* and *distinct* groups based on their values on several different variables (Everitt & Dunn 2001; Everitt & Hothorn 2011; Everitt et al. 2011). The purpose of using cluster analysis is to acquire an in-depth understanding of countries and their features. Therefore, there are no explicit hypotheses to be tested regarding how the indicators are configured or how resulting configurations are related to the gender difference in adult numeracy.

The chosen method to derive the final clusters is k-means clustering. K-means clustering works via an algorithm which tries to find the grouping of *n* cases into the number of groups that minimises the within-group sum of squares (WGSS) across all variables. An alternative to k-means clustering is a technique known as agglomerative hierarchical clustering. While both techniques are based on similar distance measures, k-means clustering proceeds in a single step, whereas agglomerative hierarchical clustering consists of a series of partitions of the data, ultimately resulting in a single cluster. The solution therefore needs to be 'cut' at some point in the process to obtain an optimal partition of the data among the nested sequence of clustering (Everitt & Dunn 2001). The use of different clustering techniques can give different results, even with the same data.

As well as different techniques giving different results, cluster analysis is highly sensitive to the indicators and cases included. This means various solutions must be compared and evaluated (Everitt et al. 2011). To address the fact that different clustering techniques can yield different results with the same data, the cluster analysis was re-run using the agglomerative hierarchical technique. The dendograms (hierarchical classification tree diagrams) from this analysis are displayed in Appendix

Figure A6.1. However, ultimately, the k-means result was preferred because it provided a clearer distinction on the variables of interest and created sensibly sized clusters. The hierarchical solution created clusters of very different sizes (e.g. in the complete distance solution, one cluster with eight countries in a five cluster solution, or at least eight single country or two country clusters). To address sensitivity to indicators and cases, I completed a sensitivity analysis, sequentially removing single indictors and re-running the k-means clustering procedure. Appendix Table A6.6 shows the results of this analysis, which indicates if and how the grouping of countries is altered by the removal of selected indicators. It shows that the placement of Germany, Ireland, the Netherlands, and the Czech Republic was affected by the selection of indicators, with these countries changing countries relatively frequently across the sensitivity analysis. However, apart from these countries, the groupings were relatively stable. In particular, Nordic countries, post-Soviet countries and East Asian countries were grouped together very consistently. The sensitivity analysis also indicates which variables are influential in the cluster solution. This is discussed in further detail in section 6.6.

Selection of countries

16 countries included in the cluster analysis. Canada, Finland, and Estonia did not have sufficiently detailed data on occupations to create the occupation numeracy-intensiveness measure. As this was one of the key variables to be used in the cluster analysis, these countries could not be included. Italy did not have data on the gender culture indicators for the relevant years, and therefore also could not be included in the analysis. The selection of countries is therefore even more limited than in the

previous chapters. This will obviously reflect the results and interpretation, which I discuss further in section 6.8 and in Chapter 7.

Independent variables at the country level

Various macro-level indicators have been selected to operationalise the dimensions of gender relations. Most of these indicators correspond to the year 2012, when the PIAAC data collection took place. The selected indicators (ten in total) and their sources are listed in Table 6.1, and each country's values on each indicator are shown in Appendix A6.4. More details on the sources of these variables and summary statistics are shown in Chapter 2. Correlations between the selected variables are also shown in Appendix A6.5. Indicators are coded so that higher values equate to 'less egalitarian'.

Table 6.1 Aspects of gender relations, indicators, sources, and variables[27]

Aspect of gender relations	Indicator	Data source	Variable name	Direction
Gender division of power	Years of education, women-men	Barro and Lee	Yearsed	Higher = female advantage in education
	Gender wage gap	OECD	Wagegap	Higher = larger gender wage gap
	Labour force participation (% of female population)	ILO	LFP	Higher = higher labour force participation
	Representation of women in parliament	World Bank Gender Statistics	Parliament	Higher = higher representation of women in parliament
Division of unpaid labour	Difference in average weekly hours of housework done by men and women	International Social Survey Programme 2012; gender roles module	Meanhours_housework_FM	Higher = women do more housework than men
Division of paid labour	Level of industry segregation	ILO: employment by sex and economic activity; dissimilarity index based on Singelmann (1978) classification scheme applied to ISIC Rev 4 categories	Dissim_industry	Higher = men and women are more segregated across industries
	New indicators of employment in low skills intensity/female-dominated occupations,	Constructed in chapter 5.	Lownum_f Highnum_m	Higher = women are over-represented in low numeracy intensity occupations/men are over-represented in high numeracy occupations
Gender culture	Male primacy	European Values Survey 2008/World Values Survey, Wave 6 (Japan, Korea, USA): 'men should have more right to work if jobs are scarce'	Jobrights	Higher = agreement with statement
	Valuation of women's' employment	European Values Survey 2008/World Values Survey, Wave 6 (Japan, Korea, USA): 'Having a job is the best way for a woman to be an independent person'	Womanwork	Higher = disagreement with statement

[27] See Figure 2.11 and Appendix A6.4 for descriptive statistics on these variables.

Cluster analysis procedure

The cluster analysis uses the indicators described in Table 6.1. Before starting the cluster analysis, each indicator is standardised, to avoid results being skewed by the different measurement scale of variables. A distance matrix is also calculated based on Euclidean distances. This matrix is the basis of the cluster procedure.

The clustering algorithm then works through number of steps:

1) Find an initial grouping of cases
2) Calculate the change in the clustering criterion (i.e. the WGSS) which results from moving each case from its own cluster to another cluster.
3) Make the change that leads to the greatest improvement in the value of the WGSS.
4) Repeat steps 2 and 3 until no move of an individual case causes the WGSS to improve.

(Everitt & Hothorn 2011)

There are different methods that can be used to decide on the number of clusters. For this analysis, I plotted the WGSS for K-means solutions from one to six clusters. With such a plot one can see the 'elbow' where the change in the WGSS is no longer notable from one cluster solution to the next (similar to the scree-plot used in factor analysis). The plot indicated that five clusters would be most appropriate for these data (see Appendix Figure A6.2).

The clusters are then described in terms of their average features on each of the indicator variables. To better understand the way the algorithm has grouped the cases, Everitt and Hothorn (2011) suggest that the cases can be plotted within the space of key indicators. This is done in Figure 6.2.

Descriptive analysis and two-step regression

Having completed the cluster analysis and decided on a cluster solution, I first use descriptive analysis (graphical comparison of means) to compare the gender difference in adult numeracy across clusters. These results are presented separately for different age groups and skill levels as in previous chapters. I then run two-step models according to the method described in Chapter 2. The analysis focuses on the 'residual' gender differences in adult numeracy which result from the individual-level analyses in chapters 4 and 5 and refer to three groups of adults: 25–34–year-olds, 55–64-year-olds and working adults aged 25–65. This residual difference can be thought of as the difference 'unexplained' by accounting for individual-level variables. This is modelled as a function first of the individual indicators of gender relations in Table 6.1, and then as a function of cluster membership.

6.6 Results

Descriptive statistics – cross-national variation in the gender difference in adult numeracy

Figure 6.1 revisits gender differences in adult numeracy that were unexplained by controlling for individual-level variables[28]. This figure summarises the cross-country variation that I wish to explain using multidimensional clusters of gender relations.

The top panel of Figure 6.1 shows the average gender difference in numeracy among adults aged 25–34, when controlling for demographic variables, educational attainment, and educational field of study. We can see there is still cross-national variation in this age group. The difference is relatively low in the Slovak Republic and Poland and relatively high in Denmark and Estonia. It should be noted

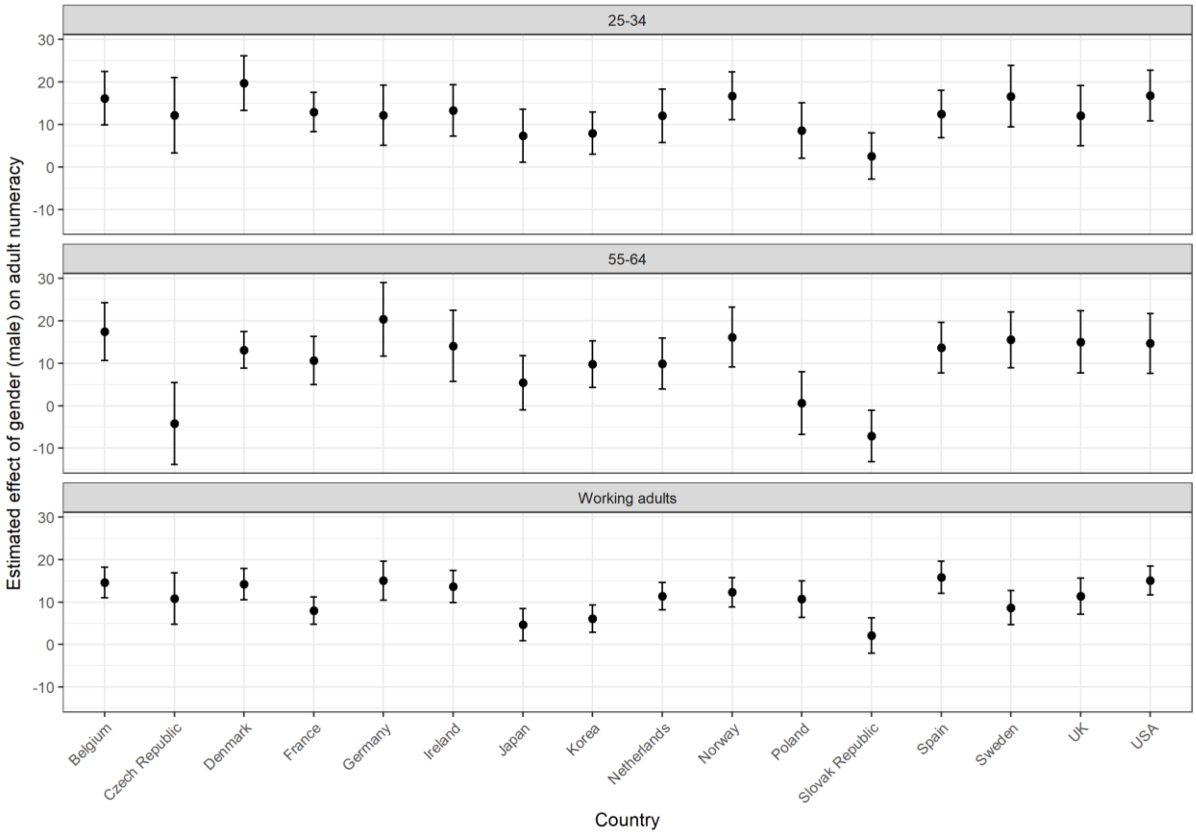
[28] For reasons of space, only average gender differences are presented here. For the residual gender differences at high and low numeracy skills levels among the three samples, see Appendix Tables A6.1 and A6.2.

that these cross-country comparisons vary from those made in Chapter 3, because in the majority of countries the gender difference in this age group *increased* when controlling for educational variables.

The middle panel of Figure 6.1 shows the average gender difference in numeracy among adults aged 55–64. One can immediately see that the residual gender difference in this age group is more variable than in the younger age group. One reason for this is that the gender difference is very low in post-Soviet countries the Czech Republic, the Slovak Republic, and Poland. Another reason is that in this age group, the addition of educational variables *decreased* the gender difference dramatically from its initially high level in Japan, Korea, and the Netherlands. While the difference in Germany reduced to some extent, it remains the country with the largest gender difference in this age group.

The bottom panel of Figure 6.1 shows the residual (unexplained) gender difference in adult numeracy among working adults aged 16–65, when controlling for educational variables, job-related variables and occupational numeracy-intensiveness, the measure created in Chapter 5. This figure shows a different pattern of variation to that seen in the previous figure. In this sample, the residual gender difference becomes relatively small in Japan, Korea, and France; while remaining relatively large in Belgium, Germany, Ireland, Norway, Sweden, and the USA. This reflects two phenomena: (1) the gender difference among working adults was relatively small in Japan and Korea to start with and (2) in these countries, gender differences reduced when controlling for occupation numeracy-intensiveness. While there was some reduction in the individual-level average gender difference on the basis of occupational numeracy-intensiveness in the Nordic countries, differences remained substantial suggesting that the difference was not completely explained and also reflecting the increases that occurred when controlling for educational variables.

Figure 6.1 'Residual' gender differences in adult numeracy, PIAAC 2012



Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. Gender coefficients represent differences in average scores when controlling for a range of individual-level variables. For the 25–34 and 55–64 samples, the coefficients are average differences when controlling for immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), and field of study (science + mathematics; engineering, and a missing field dummy, compared to all other fields). For the working adult sample, the models control additionally for age, occupational status (ISEI score), sector of employment (Singelmann industry classifications), and numeracy-intensiveness of occupation (average numeracy-intensiveness score, as calculated for each country-occupation in Chapter 5).

Cluster analysis

The k-means clustering procedure identified five clusters of countries. The cluster memberships are shown in Table 6.2. Further description of the clusters and justification of their naming follows the table. The clusters are similar to the regional groupings of countries found in previous cross-national studies of gender, education, and employment (Mandel 2009; Steinmetz 2012; Blossfeld et al. 2015). For example, Steinmetz's 'Conservative sex segregation regime' incorporates many of the same countries as the 'Continental' regime identified here, including Belgium, France, and Germany; while

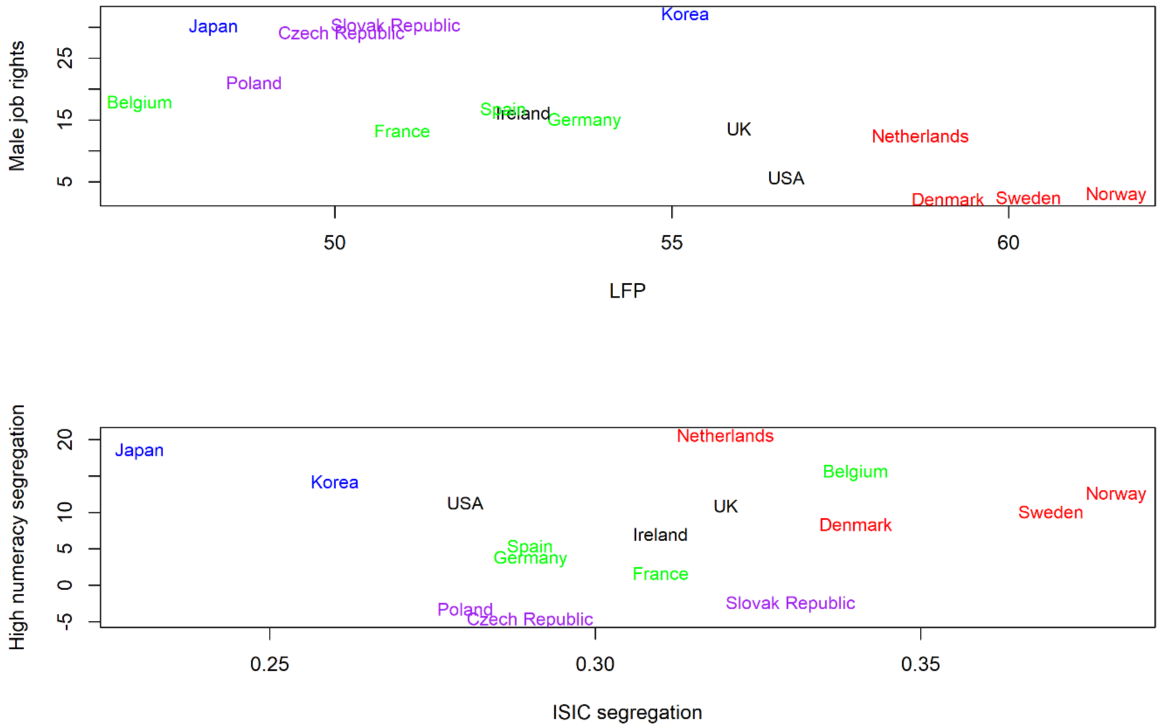
Nordic countries (Denmark, Sweden and Norway, along with the Netherlands) and liberal, Anglophone countries (Ireland, UK, and USA), respectively, cluster together. Figure 6.2 shows how individual countries sit within some of the main indicators of gender relations: gender culture (the 'male job rights' indicator) and labour force participation in the top panel, and different forms of labour force gender segregation in the bottom panel. Descriptive statistics for each indicator by cluster are shown in Table 6.4.

The cluster solution is inherently sensitive to the inclusion or exclusion of individual indicators. Results of a sensitivity analysis, shown in Appendix A6.8, suggest that particular indicators are influential in this analysis: female labour force participation, the gender wage gap, and female over-representation in low numeracy-intensiveness occupations. Removing these indicators results in re-orientation of the clusters, particularly in the case of the Continental and Anglophone countries, whereas the Nordic and post-Soviet countries tend to group together more consistently. It should be noted that these clusters refer only to gender relations as measured in or around the year 2012. This time-specificity is discussed further in the conclusion.

Table 6.2 Clusters of gender relations in 16 OECD countries

Cluster 1: East Asian	**Cluster 2: Nordic**	**Cluster 5: Anglophone**
Japan	Denmark	Ireland
Korea	Netherlands	UK
	Norway	USA
	Sweden	
Cluster 3: Post-Soviet	**Cluster 4: Continental**	
Czech Republic	Belgium	
Poland	France	
Slovak Republic	Spain	
	Germany	

Figure 6.2 Clusters and variables



Cluster descriptions

Cluster 1: East Asian

In Cluster 1, comprising Japan and Korea, women have low economic power by all measures: more men than women participate in higher education, female labour force participation is the lowest of the four clusters, there are low numbers of female MPs (particularly in Japan) and a gender pay gap of 31 per cent on average. Women do more housework than men by 12 hours per week. In terms of gender culture, these countries are the most traditional, with 30 per cent agreeing that men should have more rights to jobs in times of scarcity. However, a low proportion disagree that ‘having a job is the main way for women to be independent’, which suggests that women participating in the labour force does not necessarily contradict more traditional beliefs about male primacy.

Women are over-represented in low numeracy-intensiveness occupations, and under-represented in high numeracy-intensiveness occupations. However, despite women's low economic power, gender segregation across industries is relatively low (see Figure 6.2), which may indicate relatively good occupational attainments for those women who do enter the labour market. This highlights what was already shown in Chapter 5: that segregation on the basis of numeracy-intensiveness is a distinct, hybrid form of segregation which may reflect both horizontal and vertical aspects. Moreover, it is present in these East Asian countries, which are highly traditional in other respects and have previously been described as having low levels of horizontal gender segregation in employment (Charles & Grusky 2011).

Cluster 2: Nordic

Cluster 2 consists of Nordic countries (Denmark, Norway, and Sweden), along with the Netherlands. In this configuration of gender relations, women have relatively high levels of economic power, with high educational and labour force participation, a high proportion of female MPs, and a relatively low gender wage gap. Women's high labour force participation in Nordic countries is often attributed to their well-developed systems of family benefits and parental leave policies (Mandel 2009; Steinmetz 2012). Quotas and positive discrimination are credited with increasing women's political representation (Norris 2001). The Nordic cluster shows the lowest gender difference of all clusters in terms of housework hours. These countries are characterised by the most egalitarian gender culture, with low levels of agreement that males have primacy over jobs, and relatively low levels of disagreement with the statement that 'having a job is the main way for women to be independent' (although interestingly, the Nordic cluster is similar to the Post-Soviet cluster the latter belief). The Netherlands exhibits a relatively high level of disagreement with this statement compared to the other countries (30 per cent), which brings up the cluster average.

The Nordic cluster is also characterised by high levels of gender segregation across industry sectors, notable over-representation of women in low numeracy-intensiveness occupations, and under-representation in high numeracy-intensiveness occupations. This fits with the description of Nordic countries as having high levels of formal equality combined with high levels of labour market segregation (e.g. Mandel & Semyonov 2006; Charles & Grusky 2011), portrayed as representing a sort of 'hybrid' character of gender relations (Charles & Grusky 2004). Indeed, the profile of this cluster is congruent with Charles and Grusky's depiction of Nordic societies as having achieved relatively little vertical stratification, a belief in equality and equal economic role of men and women, alongside substantial segregation in the paid labour force.

The placement of the Netherlands in the 'Nordic' cluster is potentially problematic since it is not situated in the Nordic region, nor does it share the common social-democratic history of Denmark, Norway, and Sweden. The Netherlands shares some features with the Nordic countries but does not have the exact same profile. As Table 6.3 shows, the Netherlands is similar to the Nordic countries in terms of female labour force participation, political representation, and housework hours. This reflects the observation that the Netherlands has followed a 'Nordic' model, enabling women's labour force participation by increasing women's part-time employment opportunities (Steinmetz 2012). It is most similar to Sweden in terms of the gender wage gap, and most similar to Norway in terms of female over-representation in low numeracy occupations. However, the Netherlands is closer to the Anglophone countries in terms of gender role attitudes, which are not quite as 'egalitarian' as the Nordic countries.

The Netherlands has long been something of an 'outlier' in comparative social policy typologies, aligning with different countries depending on the dimension of social policy or the time period considered (Goodin & Smitsman 2000). In other typologies of gender relations developed using cluster analysis, the Netherlands is sometimes placed alongside continental countries like Germany, France and Belgium and Anglophone countries like the UK and Ireland (e.g. in Steinmetz 2012). Steinmetz (2012) also notes the distinctiveness of the Netherlands in that it emerges as a single cluster in some iterations of her analysis. To check for this possibility in the present analysis, four and six- cluster solutions have also been computed. However, with this set of countries and this selection of indicators, the Netherlands consistently groups with the Nordic countries across four, five and six-cluster solutions (see Appendix Tables A6.7 and A6,8). The descriptive statistics for other countries in Table 6.3 (Denmark, Norway and Sweden) justify the claim that, even without the Netherlands, Nordic countries exemplify a mix of egalitarianism and segregation, compared to the other countries in the analysis, as is also suggested by a number of previous studies (e.g. Mandel & Semyonov 2006; Charles & Grusky 2004; Charles & Grusky 2011) (see also Appendix Table A6.4).

Table 6.3 Descriptive statistics for individual countries in Nordic cluster

	Division of power				Division of unpaid labour	Division of paid labour			Gender culture	
Country	Yearsed	LFP	Parliament	Wagegap	Meanhours_housework_FM	Dissim_industry	Lownum_F	Highnum_F	Jobrights	Womanwork
DNK	0.6	59.1	39.1	7	3.3	0.34	10.39	8.42	2.3	11.5
NLD	-0.05	58.7	38.7	14.11	3.7	0.32	17.62	20.61	12.5	30.5
NOR	0.35	61.6	39.6	6.41	2.8	0.38	15.79	12.43	2.9	16.2
SWE	0.77	60.3	44.7	15.14	3.8	0.37	7.73	10.12	2.5	19.7

DNK=Denmark, NLD=Netherlands, NOR=Norway, SWE=Sweden.

Cluster 3: Post-Soviets

Cluster 3 comprises the post-Soviet countries – the Czech Republic, the Slovak Republic, and Poland. On average across these countries, there is little difference between men and women in terms of years of education. These countries can be classed as intermediate compared to the other clusters when it comes to the other indicators of economic power – on average, 50 per cent of women participate in the paid labour force (similar to the Continental and East Asian clusters). These countries are also characterised by a traditional gender culture, with relatively high levels of support for male primacy in the labour market (27 per cent agree or strongly agree that men should have priority when jobs are scarce). In terms of levels of disagreement with the belief that ‘having a job is the main way for a woman to be independent’ this cluster is similar to Cluster 2, which comprises mainly Nordic countries (19 per cent disagree). If this level of disagreement indicates a devaluation of women’s employment and a belief that women should also be mothers and caretakers, this reflects the conservative tone of beliefs about male primacy. However, the level of disagreement is not as high as in the Anglophone countries, which could indicate that women’s employment is relatively well-valued, alongside beliefs in male primacy. This apparent contradiction may suggest that present-day post-Soviet societies represented here are oriented towards a ‘dual earner female double burden’ model, which is linked to Soviet-era full employment policies (Pascall & Manning 2000). In other words, male primacy is subscribed to, but women’s work is also important. This may also reflect a phenomenon referred to by Knight and Brinton (2017) as ‘egalitarian familism’, defined by the belief that women should be active members of the labour force, combined with a belief in male primacy and a conviction that family and home are essential to women’s identity.

Post-Soviet countries exhibit almost *no segregation* in terms of high numeracy-intensiveness and low numeracy-intensiveness occupations, as identified in Chapter 5 and shown clearly in Figure 6.2. In fact, on average, women are slightly *more* likely than men to be employed in high numeracy-intensiveness occupations.

Cluster 4: Continental

Cluster 4 comprises a collection of continental European countries: Belgium, France, Germany, and Spain. The cluster is characterised by around half of the female population employed in the paid labour force, between 20–30 per cent female MPs, and a gender pay gap of 11 per cent on average. However, countries within this cluster are quite heterogeneous in terms of these indicators (see Appendix A6.4). In terms of gender culture, these countries are slightly more traditional than the Nordic cluster in their agreement with the belief that male primacy in employment is important to their independence, but on average 14 per cent disagree that working is the main way for women to be independent, suggesting that most people believe that women's economic role is important. As noted by Steinmetz (2012), several continental European countries, including Germany and Belgium, subscribe to a model of social policy that favours the male breadwinner model, where women are seen as caregivers as well as a secondary, part-time labour force. The Continental cluster's relatively low female labour force participation and relatively conservative attitudes on male primacy in the labour market may reflect these realities. In terms of the segregation indicators developed in Chapter 5, male over-representation in high numeracy-intensiveness occupations and female over-representation in low numeracy-intensiveness occupations is observable but is not as extreme as in the Nordic and East Asian clusters.

Cluster 5: Anglophone

Cluster 5 comprises Anglophone countries, the UK, the USA, and Ireland, often described as 'liberal' in socio-economic country typologies, due to their principal reliance on market functioning, in contrast to state support, to determine social welfare (Esping-Andersen 1999). The cluster is characterised by a relatively high proportion of the female population employed in the paid labour force (55 per cent). As noted by Steinmetz (2012), this is likely linked to highly developed service sectors and good part-time opportunities. However, these countries are also characterised by a relatively high gender pay gap and relatively low representation of women in parliament, particularly when compared to the Continental and Nordic clusters. In terms of gender culture, a relatively small proportion of citizens in these countries support a male primacy model, suggesting relatively egalitarian gender culture. However, in contrast, a relatively high proportion disagree that ‘work is the main way for women to be independent’, suggesting that support for female employment is not as high as in Continental and East Asian countries, or that varied roles for women, or freedom of choice, are valued. Male over-representation in high numeracy-intensiveness occupations is a more pronounced phenomenon that female over-representation in low numeracy-intensiveness occupations, but neither are as extreme as in the Nordic or East Asian clusters.

Table 6.4 Clusters of gender relations in 16 OECD countries: descriptive statistics

	Division of power				Division of unpaid labour	Division of paid labour			Gender culture	
Cluster	Yearsed	LFP	Parliament	Wagegap	Meanhours_housework_FM	Dissim_industry	Lownum_F	Highnum_F	Jobrights	Womanwork
East Asian	0.39	51.70	11.80	31.41	12.40	0.25	10.67	16.33	31.10	6.70
Nordic	0.42	59.93	40.53	10.67	3.40	0.35	12.88	12.90	5.05	19.48
Post-Soviet	0.19	49.93	21.47	13.95	6.83	0.30	-5.15	-3.54	26.70	19.00
Continental	0.28	51.08	33.45	10.85	8.38	0.31	7.21	6.48	15.63	14.23
Anglophone	0.41	55.17	18.53	15.12	4.27	0.30	3.95	9.76	11.83	29.87

Source: Author’s calculation using supplementary data sources described in Table 6.1. Each country’s values on each variable can be found in Appendix A6.4.

Gender differences in adult numeracy by cluster

Having described the configurations of gender relations in each of the five clusters, the chapter now focuses on the extent to which particular configurations of gender relations are associated with gender differences in adult numeracy. This analysis is used to evaluate whether the data support the idea that gender differences in adult numeracy are associated with gender inequality, or whether the relationship between gender relations at the national level and gender differences in adult numeracy is more complex and multidimensional.

Figure 6.3 shows gender differences among 25–34-year-olds, by cluster. The position of each individual country is also marked on the plot, to display the variation within each cluster. The first panel shows the average differences; the middle panel shows the odds ratio for males achieving low numeracy levels (larger odds ratios equate to smaller gender differences); while the lower panel shows the odds ratio for males achieving high numeracy levels (larger odds ratio equate to larger gender differences). The outcome variable in all cases is the *residual* gender difference in adult numeracy, in other words, the portion of the overall gender difference that has not been explained by the individual-level variables analysed in Chapter 4.

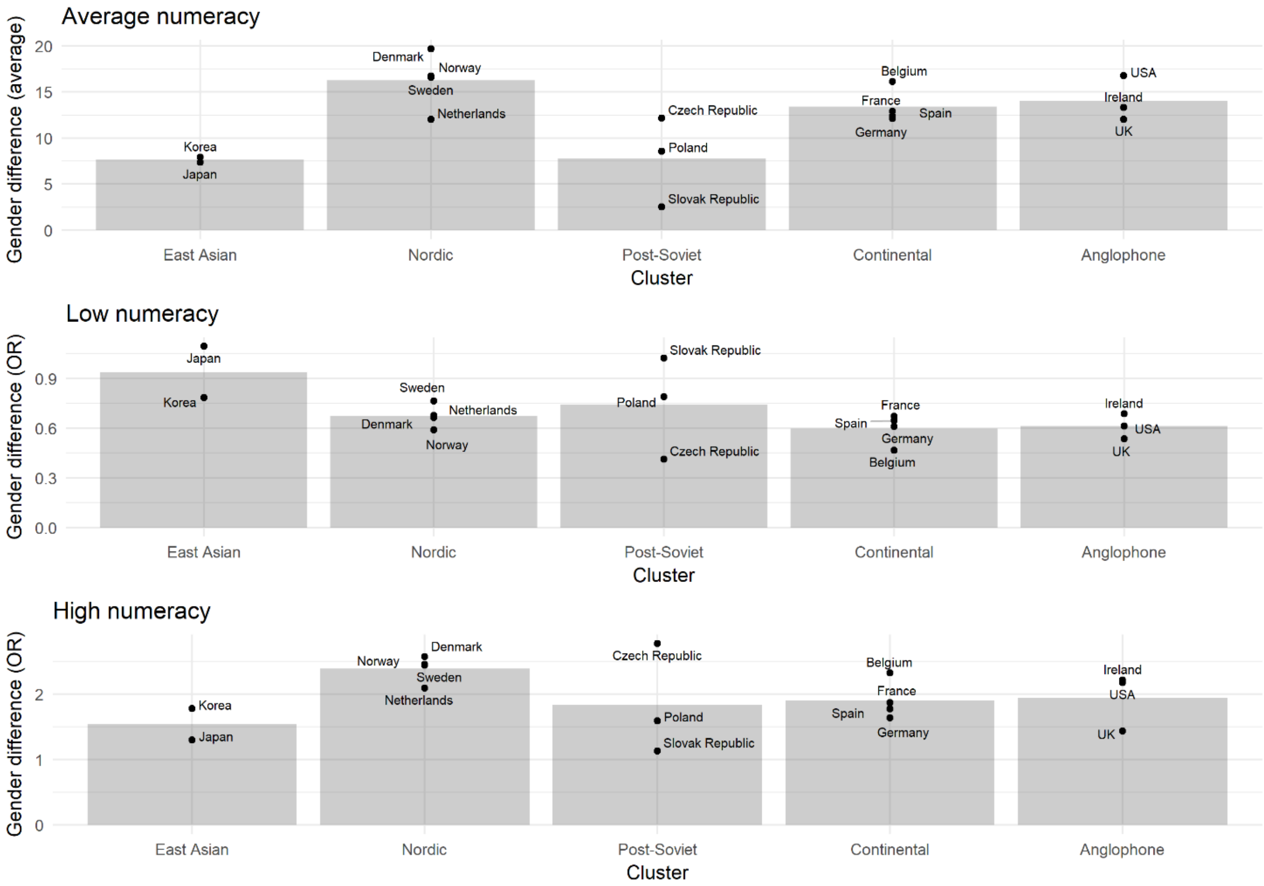


Figure 6.3 Gender differences in adult numeracy at three skill levels, adults aged 25-34, by cluster

Source: Author's calculation using the PIAAC dataset and supplementary data. Gender differences (average) represent differences in average scores when controlling for immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), and field of study (science + mathematics; engineering, and a missing field dummy, compared to all other fields) at the individual level. Gender differences (odds ratios) at low and high numeracy levels represent the odds ratios of achieving below 238 points and above 304 points respectively, with the same control variables included.

The East Asian cluster, the most 'traditional' in terms of its gender relations, consistently has the lowest gender differences across all three skill levels. At average and high levels of numeracy, the largest difference is seen in the Nordic cluster, the most 'egalitarian'. In this cluster, men are more than twice as likely as women to reach high numeracy levels. While the Post-Soviet cluster is similar to the East Asian cluster in that its average gender difference is relatively low, it is comparable to the Nordic cluster with respect to gender differences at low levels of numeracy, and comparable to the Anglophone and Continental clusters with respect to gender differences at high levels of numeracy. Moreover, there is quite a lot of heterogeneity within this cluster: while the Slovak Republic shows consistently low gender differences, the other countries' differences vary according to the skill level considered. Therefore, the main variation is between the Nordic cluster and all other clusters, though there is less cross-cluster variation at low numeracy levels. Overall, among young adults, East Asian and Post-Soviet clusters have similar outcomes, despite their diverse patterns of gender relations.

Turning to gender differences among older adults (Figure 6.4), patterns are very distinct from those for younger adults. The Post-Soviet cluster shows consistently low gender differences across all three skill levels. The Nordic, Anglophone, and Continental clusters show similar gender differences across the skill levels: men on average across these clusters score 15 points higher, are more than twice as likely to achieve high numeracy levels, and 30 per cent less likely to score at the lowest levels of numeracy. The odds ratio for men achieving high levels of numeracy is slightly higher in the Anglophone cluster, driven up by the particularly large male advantage in Ireland. Women in Japan and Korea are less disadvantaged on average, but men are still much more likely to achieve the highest levels of numeracy. Therefore, for older adults, the main aspect of variation is between the Post-Soviet cluster and all the other clusters.

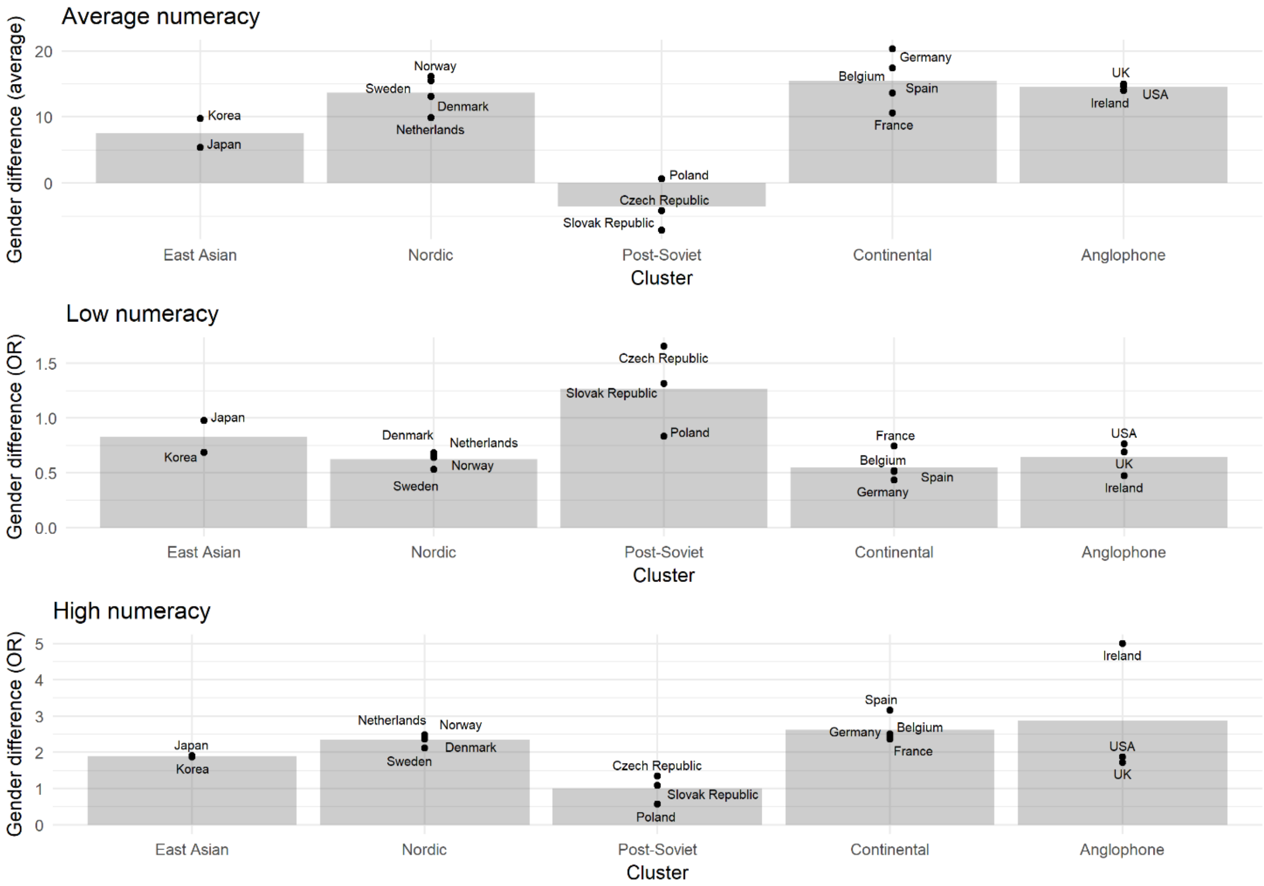


Figure 6.4 Gender differences in adult numeracy at three skill levels, adults aged 55–64, by cluster

Source: Author's calculation using the PIAAC dataset and supplementary data. Gender differences (average) represent differences in average scores when controlling for immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), and field of study (science + mathematics; engineering, and a missing field dummy, compared to all other fields) at the individual level. Gender differences (odds ratios) at low and high numeracy levels represent the odds ratios of achieving below 238 points and above 304 points respectively, with the same control variables included.

Figure 6.5 displays the gender differences by cluster for working adults, where patterns are distinct from the other two analytic samples. Here, the largest differences are in the Continental and Anglophone clusters, while women in the East Asian cluster are much less disadvantaged at all levels of numeracy. However, the lack of women at high levels of numeracy is still apparent in the East Asian cluster. In the Post-Soviet cluster, the gender difference on average is relatively low; however, women are still at a disadvantage at the highest and lowest skill levels. Gender disparities in achieving the highest levels of numeracy are particularly pronounced in the Continental and Anglophone clusters.

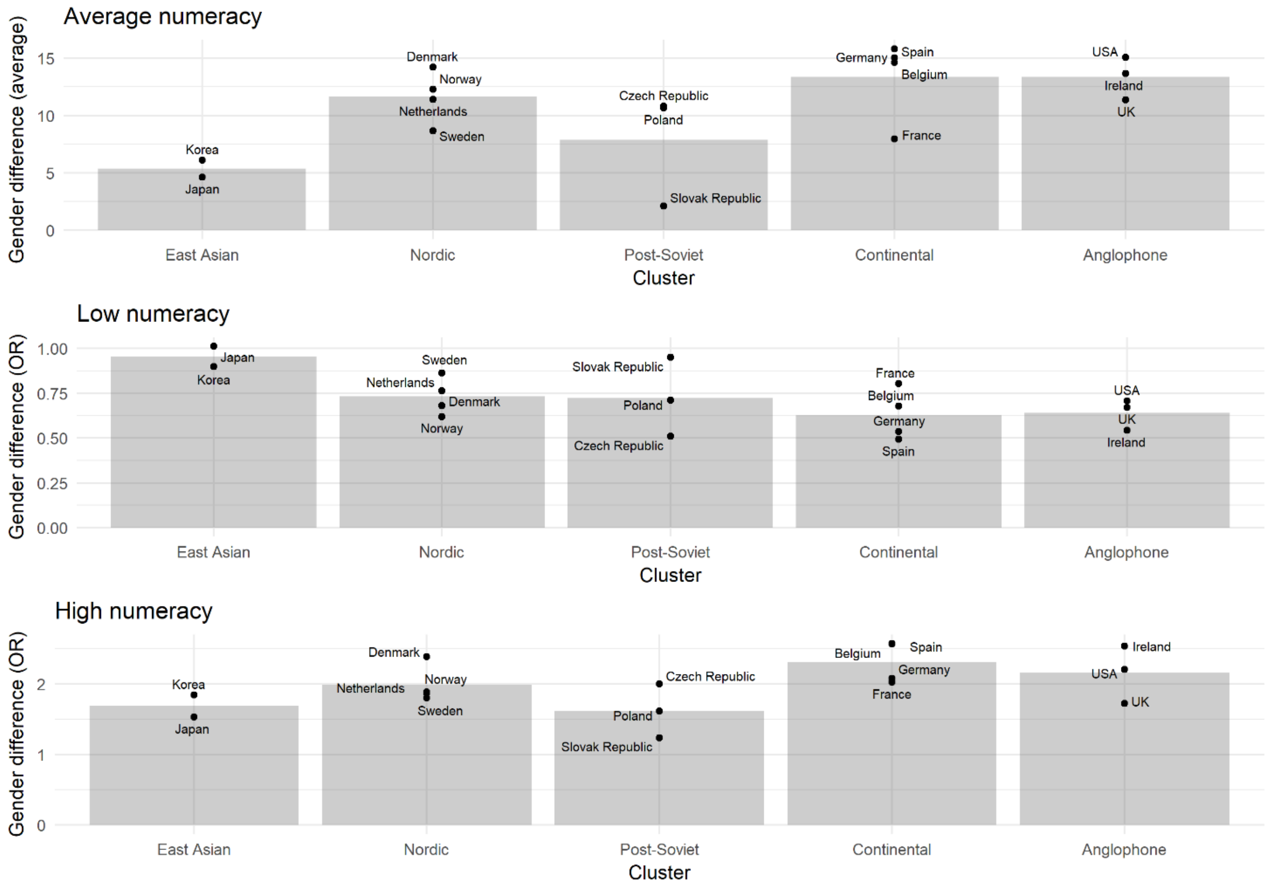


Figure 6.5 Gender differences in adult numeracy at three skill levels, adults aged 55–64, by cluster

Source: Author's calculation using the PIAAC dataset and supplementary data. Gender differences (average) represent differences in average scores when controlling for immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), and field of study (science + mathematics; engineering, and a missing field dummy, compared to all other fields), age, occupational status (ISEI score), sector of employment (Singelmann industry classifications) and numeracy-intensiveness of occupation (average numeracy-intensiveness score, as calculated for each country-occupation in Chapter 5) at the individual level. Gender differences (odds ratios) at low and high numeracy levels represent the odds ratios of achieving below 238 points and above 304 points respectively, with the same control variables included.

To model variation between clusters in the gender difference in adult numeracy more formally, I next show a selection of two-step regression models. The first set of models use separate indicators of gender relations (Table 6.4) while the second set of models (Table 6.5) instead use cluster membership as the main explanatory variable.

Table 6.5 shows results from a regression model predicting the gender difference in adult numeracy at the country level based on the separate indicators of gender relations. The indicators were entered into the model in four blocks representing the different dimensions of gender relations: the gender division of power, the gender division of paid labour, the gender division of unpaid labour, and gender culture. Overall, very few associations are found between any individual indicator of gender relations and the gender difference in adult numeracy. However, across the age groups, a more conservative gender culture with respect to views about male primacy in the labour market (as seen in the East Asian and Post-Soviet clusters) is associated with a lower gender difference in numeracy. Moreover, among young adults, gender inequality in housework hours is also associated with a lower gender difference in adult numeracy. Conventional indicators of gender equality and 'empowerment', such as female labour force participation and the gender pay gap, are not good predictors of cross-country variation in the gender difference in adult numeracy.

The results in Table 6.6 show that cluster membership, which combines different configurations of indicators of gender relations, more successfully predicts cross-country variation in the gender difference in adult numeracy. It provides a more definitive answer to the question of which profile of gender relations is associated with larger gender differences in adult numeracy, and in which cluster the association between gender and numeracy is attenuated[29]. The regression results confirm that, across all three samples, the gender difference in adult numeracy is significantly lower than in the East Asian cluster compared to the other clusters. Among young adults, the contrast between the Nordic and East Asian cluster is particularly strong, as the average gender difference is 8.5 points higher in the former cluster than in the latter. Among young adults and working adults, the post-Soviet and East

[29] In all these models, the gender difference in mathematical attainment in PISA is included as a control variable in order to account to some extent for any pre-existing differences among adolescents and to treat the gender difference among adults as a distinct phenomenon to be explained. Since it made no difference to the results, it was omitted from the final models.

Asian clusters are not significantly different from one another. However, in the older adult age group, the post-Soviet countries show a substantially and significantly smaller gender difference compared to the other clusters.

Table 6.5 Results from a two-step regression model predicting country level gender differences in adult numeracy based on individual indicators of gender relations

	Young adults (25–34)								Older adults (55–64)								Working adults (16–65)							
Gender division of power																								
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
LFP	1.86	1.05							1.99	2.37							0.51	1.22						
Parliament	1.36	1.33							3.13	2.99							0.44	1.53						
Wagegap	-0.81	1.13							0.93	2.68							-1.91	1.39						
Yearsed	1.53	0.97							1.52	2.08							-0.31	1.09						
Gender division of unpaid labour																								
Meanhours_housework_FM			**-2.34***	1							-1.45	2							-1.02	1.04				
Gender division of labour																								
Lownum_f					1.37	1.26							1.67	2.16							0.5	1.43		
Highnum_m					0.51	1.31							3.02	0.19							0.02	1.43		
Dissim_industry					2.02	1.02							1.93	1.74							0.75	1.15		
Gender culture																								
Womanwork							-0.36	0.64							-0.5	1.64							0.68	0.91
Jobrights							**-3.99*****	0.62							**-5.07****	1.6							**-2.25***	0.92
Rsquared	0.47		0.23		0.39		0.73		0.06		-0.03		0.23		0.36		0.09		0		-0.18		0.29	
Intercept	12.32		12.26		12.25		12.26		10.24		10.33		10.2		10.24		10.89		10.87		10.88		10.83	
N	16		16		16		16		16		16		16		16		16		16		16		16	

Table 6.6 Results from a two-step regression model predicting country-level gender differences in adult numeracy based on cluster membership

	Young adults (25–34)		Older adults (55–64)		Working adults (16–65)	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**
East Asian	ref		ref		ref	
Anglophone	**6.53***	2.46	**6.70***	2.95	**8.05***	2.82
Continental	**5.58***	2.22	**6.56***	2.6	**7.74***	2.67
Nordic	**8.50****	2.31	**5.42***	2.47	**6.27***	2.65
Post-Soviet	-1.42	2.51	**-11.95****	2.95	2.07	2.94
Adj. Rsquared	0.61		0.86		0.39	
Intercept	7.72		7.91		5.42	
N	16		16		16	

Tables 6.7 and 6.8 summarise the results from models predicting gender differences in numeracy at high and low numeracy levels, based on cluster membership. Among working adults, women in Anglophone and Continental countries are particularly likely to be low skilled in numeracy, and, in Continental countries, particularly unlikely to be high skilled. Young women in Nordic countries are particularly unlikely to reach the highest levels of numeracy, compared to male counterparts, while older men in post-Soviet countries are much less likely than older adults in other clusters to outperform their female counterparts at the highest levels of numeracy. These results largely support the findings for average skill levels, suggesting disadvantage for working women in Continental and Anglophone countries, particularly compared to East Asian countries; disadvantage for young women in Nordic countries, and relative advantage for older women in post-Soviet countries.

Table 6.7 Results from a two-step regression model predicting country level gender differences in low and high adult numeracy based on individual indicators of gender relations: summary table

	Low numeracy			**High numeracy**		
	Young adults	Older adults	Working adults	Young adults	Older adults	Working adults
LFP						
Parliament						
Wagegap						
Yearsed						
Meanhours_housework_FM						
Lownum_f						
Hignum_m						
Dissim_industry						
Womanwork						
Jobrights					**-0.32**	

Source: Author's calculations using supplementary data and PIAAC 2012. Empty cells indicate no statistically significant association. Light grey cells indicate a negative association at $p < 0.05$ or less. Dark grey cells indicate a positive association at $p < 0.05$ or less. N=16 countries in all models.

Table 6.8 Results from a two-step regression model predicting country-level gender differences in low and high adult numeracy based on cluster membership: summary table

	Low numeracy			**High numeracy**		
	Young adults	Older adults	Working adults	Young adults	Older adults	Working adults
Cluster (ref: East Asian)						
Anglophone			**-0.31**			
Continental			**-0.32**			**0.59**
Nordic				**0.85**		
Post-Soviet					**-0.96**	

Source: Author's calculations using supplementary data and PIAAC 2012. Empty cells indicate no statistically significant association. Light grey cells indicate a negative association at $p < 0.05$ or less. Dark grey cells indicate a positive association at $p < 0.05$ or less. N=16 countries in all models.

6.7 Discussion

A frequent proposition in comparative research on gender differences in numeracy and mathematical skills is that the gender difference (i.e. the male advantage) is larger countries with more gender inequality. In countries where gender inequality is less pronounced, the gender difference in numeracy is predicted to be lower. While this may seem to be a 'common sense' proposition, evidence against it accumulating. Statistically robust associations between measures of gender inequality and gender differences in skills cannot always be obtained, and, more importantly, gender differences in numeracy remain in countries that are widely considered to be highly egalitarian. Attempts to address the confusion in this research area have been hampered by a number of methodological and conceptual difficulties which limit comparability between studies, such as different samples of countries and different analytical approaches to measuring the gender difference in skills. I argue that scholarly progress in this area has been further hampered by narrow definitions of gender inequality, which do not consider the varied ways countries structure gender relations, nor the fact that countries can exhibit both egalitarian and inegalitarian features simultaneously.

Focusing on the under-researched area of *adult* numeracy skills, this chapter has built on previous studies which have explored the determinants of cross-national variation in gender difference in numeracy skills, using a sample of 16 OECD countries. Drawing on insights from feminist scholarship on gender relations, which particularly highlights the key role of segregation and gender culture alongside conventional indicators of empowerment and equality, I uncovered five distinct clusters of gender relations which each combined egalitarian and inegalitarian features. This was achieved using indicators of four theoretically-driven aspects of gender relations: the gender division of power, the gender division of labour, the gender division of unpaid labour, and gender culture.

These clusters were found to show distinct differences in their pattern of gender differences in adult numeracy. In particular, clusters with the most 'egalitarian' pattern of gender relations showed larger gender differences in adult numeracy compared than countries with more 'traditional' gender relations, characterised by relatively low levels of economic empowerment among women, a large gender wage gap and the most unequal division of household labour. Therefore, in this sample of countries, there is no evidence that gender differences in numeracy are uniformly associated with gender inequality in access to economic power or 'empowerment'. This is the most important finding of the chapter. I now describe the further features of the clusters of countries to further contextualise this key finding.

The East Asian cluster, comprising Japan and Korea, can be viewed as the most 'traditional' in terms of the gender distribution of economic power, as well as exhibiting a somewhat traditional gender culture and a high level of segregation in terms of numeracy-intensive jobs. According to the gender stratification hypothesis, one would expect a relatively large gender difference in numeracy in such circumstances. However, in all samples, this cluster showed the lowest gender difference in adult numeracy. One reason for this is that individual-level factors (education, occupations) are more successful at explaining gender differences in Japan and Korea. When variation in the gender difference in adult numeracy across clusters are assessed without controlling for individual-level variables, the results are similar for young adults, but for the other age groups, the gender difference in not significantly lower in the East Asian cluster (the main difference is between the Post-Soviet cluster and all the other countries) (See Appendix Table A6.9). It is perhaps, then, more accurate to say that, in the working adult and older adult population, other countries exhibited a larger 'unexplained' gender difference than the East Asian cluster. Nonetheless, the results for this cluster suggest that the combination of traditional gender relations (power, culture, and unpaid labour) and the gender segregation of numeracy-intensive occupations at the country level are not necessarily associated with a larger gender difference in adult numeracy skills.

The second cluster identified consisted of Nordic countries Denmark, Norway, and Sweden, along with the Netherlands, and could be described as the most 'egalitarian' in terms of the gender division of power, the gender division of household labour, and gender culture. However, this cluster also exhibits segregation whereby women are unlikely to work in high numeracy-intensiveness jobs and more likely to work in jobs with low numeracy-intensiveness. In other words, the form of segregation identified in Chapter 5 is particularly intense in these countries. This mix of egalitarianism and segregation in Nordic countries has been identified in multiple previous studies (e.g. Charles 2005; Mandel & Semyonov 2006).

According to a culturalist interpretation, women in the Nordic cluster benefit from formal equality and are integrated into economic life but self-select out of the most demanding careers in favour of roles that fit more with their 'essentialist' identity as wives and mothers (Charles & Bradley 2009). Another interpretation emphasises policy decisions that lead to a situation in which women are integrated into the labour market, but their occupational attainment is limited by policies that attend to their roles as caregivers (Mandel 2009, 2011)[30]. Economic realities such as service sector size also appear to exacerbate these trends (Charles 2005; Olivetti & Petrongolo 2016). In either interpretation, this 'trade-off' between egalitarianism and segregation has resulted in a situation in which this cluster of countries, superficially the most egalitarian, show the largest gender difference in adult numeracy, particularly among younger adults. Interestingly, although the East Asian countries show similar levels of segregation, this does not lead to larger gender differences. It appears to be the unique combination of segregation and egalitarianism that gives rise to the gender differentiation of adult numeracy.

The Post-Soviet cluster represents an interesting case because its features also cannot be summarised as either 'egalitarian' or 'traditional'. Like East Asian countries, these countries tend to be fairly traditional in terms of gender culture and indicators of women's empowerment. However, in contrast to East Asian countries, post-Soviet countries show almost a total absence of segregation in terms of

[30] Since Mandel's initial studies on this issue, there has been a lively debate in the literature over this characterisation of Nordic countries. Recent studies illustrate variation between the Nordic countries that does not fit with this narrative of a trade-off between economic integration and occupational attainment (Grönlund et al. 2017).

the numeracy-intensiveness of occupations. As we saw in Chapter 5, women in these countries are actually more likely than men to work in numeracy-intensive occupations. Moreover, men are just as likely as women to work in low numeracy-intensiveness occupations. This combination of features – relative traditionalism combined with a low level of segregation in employment – may reflect a trend referred to by Knight and Brinton (2017) as 'egalitarian familism'. This is an ideology that supports two apparently contrasting imperatives: that women should have children and also have a job (Charles & Grusky 2004; Cotter et al. 2011). Knight and Brinton's research found that this ideology was particularly prevalent in former socialist societies, due to possible links to the Soviet full employment policies, which have had a lasting impact on norms and attitudes regarding gender and employment (Lippmann & Senik 2016). This cluster consistently exhibited the lowest gender differences in adult numeracy in this sample of countries, although there was some heterogeneity between countries and variation between skill levels. This cluster also exhibited small to non-existent gender differences in numeracy among the oldest adults. These results suggest that further research is needed on gender relations in post-Soviet countries and links to gendered patterns of skill development in different generations.

Continental and Anglophone countries represented somewhat of a middle ground between the other countries, although the Continental countries were more traditional in terms of female labour force participation and gender culture. Both clusters exhibited relatively large gender differences in adult numeracy among working adults. Interestingly, in the previous chapter, these differences were not explained by the occupational variables. This suggests that in these countries, skills differentiation among working adults is a problem that requires further investigation.

Overall, the results suggest that when it comes to adult numeracy, there is no obvious connection between gender inequality and the gender difference. In contrast, we find evidence of larger gender differences in societies that are more egalitarian on conventional measures (Nordic countries) and smaller differences in countries that exhibit rather inegalitarian features yet are also extremely different from one another (East Asian and post-Soviet countries). The results disrupt the idea that gender differences in numeracy and related skills will naturally disappear in more gender-equal societies. Instead, it seems that there are contradictory forces at play which undermine any potential effect of equality or economic integration on skills. This may be due to processes that have been highlighted in previous literature, for example, the suggestion that in countries with high female labour force participation, there are more opportunities for diversification and for female-typed work, which may undermine the generally positive effect of labour market integration of females' numeracy skills. There may also be an effect of socialisation, whereby, with more freedom and choice over their lives, women opt for more traditionally 'feminine' educational pathways, jobs, and skill development strategies (Charles & Bradley 2009; Cech 2013). The results may also point to continuing gender discrimination in egalitarian contexts.

The results align with an emerging body of literature on cross-national patterns in gendered attributes, which show that gender equality is associated with more, rather than less, difference. For example, gender differences in attitudes and aspirations towards STEM (whereby males feel more positively disposed to STEM) are more pronounced in more prosperous, egalitarian nations (Goldman & Penner 2014; Charles et al. 2014; Charles 2017). Research in psychology has suggested that gender differences in personality traits are more pronounced in more economically prosperous and egalitarian contexts (Costa et al. 2001; Schmitt et al. 2008). Findings such as these have been referred to as a 'paradox' (Charles 2017; Stoet & Geary 2018), and explanations have tended to focus on underlying preferences formed in early adolescence (Hakim 1991; Xie & Shauman 1997; Morgan et al. 2013; Lee et al. 2015), exacerbated by individualistic value systems. However, I suggest that rather than being approached as a total paradox, results such as these should be understood in relation to the broader configuration of gender relations within a country.

The analysis in this chapter has some limitations. First, when using exploratory multivariate methods such as cluster analysis, solutions are inherently unstable and are highly dependent on sample and indicators (Everitt & Hothorn 2011). Results may be different with different sample of countries and different indicators. I have tried to mitigate this limitation by presenting different solutions and sensitivity checks in the Appendix to Chapter 6. However, all the methods seemed to suggest similar groupings of countries. I am confident that the solution presented is a reasonable representation of these variables and countries.

The country-level indicators used in the cluster analysis pertain to recent years (mainly to 2012). While ensuring a fair comparison across countries, using indicators from a single, recent point in time is limiting, considering that gender relations have undergone substantial change in recent decades in all the countries under study, particularly in terms of female employment patterns, gender role attitudes, and gender culture (Scott et al. 1996; Braun & Scott 2009; Scott & Dex 2009; Knight & Brinton 2017). For example, post-Soviet countries have undergone very substantial societal and political change, and concurrently their citizens have transitioned from exhibiting highly traditional gender role attitudes, to supporting a model described by Knight and Brinton (2017) as 'egalitarian familism'. While this ambivalence is somewhat reflected in the profile for the post-Soviet cluster, changes over time are not considered by the present analysis. This is particularly problematic given that I examine gender differences among different age groups, who may have experienced different versions of gender relations in their lifetimes. This problem raises the challenging question of how to account for change over time when assessing the influence of gender relations on contemporary outcomes in adults of different ages, particularly in the absence of appropriate longitudinal or time-series data. What is the relevant period of the life course when this influence should be considered? In future research on this issue it would be pertinent to assess the historical pathways of gender relations, acknowledging the ways they underpin social policies and vice versa (Aboim 2010) and explore how this evolution has contributed to gender differences in skills in different generations of adults. Future research could also include measures of gender culture among different groups within society, as well as in the population as a whole (Moghadam & Senftova 2005; McDaniel 2008).

The selected indicators also, inevitably, represent only a partial view of gender relations in this sample of countries. The lack of data on certain key indicators for all the countries under study is a problem, particularly on gender culture. Gender culture, or gender role attitudes, are a multidimensional and complex phenomenon, with difficulties in the validity of measurement across countries (Braun & Scott 2009; Constantin & Voicu 2015) which may be exacerbated by selecting only a small selection of indicators, as I have done here.

A further issue relates to the difficulty of accounting for all possible aspects of variation across countries that may be important for explaining cross-national variation in the gender difference in adult numeracy. There are differences between countries that are not typically understood as components of gender relations, but that could feasibly influence gender differences in skills. Examples include the general culture and attitudes towards STEM that are prevalent at the national level (Mann & DiPrete 2016) and the structure of the education system (Ayalon & Livneh 2013). Furthermore, the relatively small sample of countries will undoubtedly have influenced the results in that there is less variation than with a larger sample of countries and broader generalisation is limited.

6.8 Conclusion

In conclusion, this chapter makes several contributions to the comparative literature on gender differences in numeracy and related skills. Firstly, it has problematised and re-evaluated the conceptualisation and measurement of gender inequality used in previous studies of cross-national patterns in gender and cognitive skills. It has identified distinctive profiles of gender relations, encompassing different aspects of social relations that are of equal importance for the characterisation of countries. Secondly, it has shown that there is no obvious relationship between 'gender inequality' and gender differences in adult numeracy. Instead, gender differences in numeracy are most pronounced in contexts where there is a combination of formal equality and a high degree of segregation. The chapter also contributes new evidence on cross-national trends in adult skills, an under-researched area, showing that national context is relevant to explaining gender differences in adult numeracy, over and above individual experiences.

When assessing the contribution of gender inequality to cross-national differences in numeracy and related skills, including adult numeracy skills, researchers must use a sharper, more realistic conceptualisation of gender inequality that considers contradictory aspects and potentially non-linear effects. This is particularly the case when researching these differences in industrialised countries, such as OECD countries, where 'equality' has been achieved on certain measures. A clear next step would be to see if a similar multidimensional model of gender relations is relevant to explaining gender differences in numeracy among individuals of different ages, including children and adolescents. While there are limitations to this analysis in terms of the sample of countries and selection of indicators, the chapter has shown that there is no simplistic linear relationship between gender inequality and gender differences in adult numeracy skills, and that the combination of formal equality and segregation may even exacerbate gender differences in adult numeracy.

7. Conclusion

The aim of this thesis was to develop and test an original theoretical framework to explain gender differences in adult numeracy cross-nationally. The analysis used the PIAAC 2012 data to evaluate the potential explanations suggested by this framework for gender differences both at the individual level, within countries, and in cross-national perspective. This concluding chapter draws together the findings from across the thesis, reflecting on their contributions to the literature and implications for future research and practice. The chapter is structured as follows: first, I re-iterate the motivation for the thesis, the research approach and research questions. In section 7.2, I synthesise the findings from across the thesis, providing answers to the research questions. In section 7.3, I discuss the implications of these findings. In section 7.4 I suggest future research that should be undertaken on the basis of the findings, before explaining some of the study's limitations in section 7.5. Finally, in section 7.6, I highlight the contributions of the thesis.

7.1 Motivation, approach and research questions

The main motivation for this thesis was the recognition that gender differences in numeracy skills among adults are an important, but poorly understood, social phenomenon. There have been decades of research on gender differences in intellectual capacities, including numeracy and related skills, and, more recently, an abundance of comparative research on the issue. However, this body of scholarship has mainly focused on numeracy and STEM-related skills among children and adolescents. Skills inequalities in adult populations are a major public policy issue, with serious implications for economic productivity and individual social functioning. Adults' numeracy skills are exercised in many and varied contexts throughout the life course, so there are many potential explanations for why these skills might vary between men and women. With this in mind, it is important to explain gender differences in numeracy in the adult population alongside, and in addition to, gender differences in skills observed earlier in the life course. An analysis of gendered skills inequality also complements existing studies of adult skills inequalities from the perspective of social background and immigration status (e.g. Green et al. 2015; Levels et al. 2017). The thesis therefore aimed to fill an obvious gap in the literature regarding cross-national gender differences in *adult* numeracy skills. It also addressed the more general dearth of knowledge on adult numeracy identified by scholars such as Coben (2003).

As well as filling an empirical gap on an important aspect of skills inequality, the thesis aimed to engage with an argument that has gained prominence in recent comparative research on gender and skills. This argument states that gender differences in numeracy skills, and particularly their variation across societies, may be partly explained by relative levels of gender equality ('the gender stratification hypothesis'). As noted across the chapters, this argument provides a limited conceptualisation of gender inequality and its effects on gendered patterns of skill development. One of the central aims of this thesis, therefore, was to re-evaluate this argument by creating and testing an alternative framework, the *integrative micro-macro framework* described in Chapter 1.Following this framework, thesis split the concept of 'gender inequality' into its component parts at the individual and societal level, in order to understand whether, how, and to what extent these component parts, conceptualised as 'gender relations', can explain gender differences in adult numeracy. By creating and testing its novel theoretical framework, the thesis therefore offers a critique of existing research that focuses only on limited measures of women's position in society to measure gender inequality, emphasising the need for a multidimensional conceptualisation and operationalisation of gender relations and their manifestation at both the individual (micro) and the collective (macro) level.

The broad research questions outlined at the start of the thesis were:

- How can we understand gender differences in adult numeracy?
- How are gender differences in adult numeracy related to gender-differentiated educational experiences?

- How are gender differences in adult numeracy related to gender segregation in the labour market?
- How are gender differences in adult numeracy related to country-level gender relations?

7.2 Synthesis of findings

The thesis answered the research questions using a quantitative secondary analysis of PIAAC data from 20 OECD countries, collected in 2012. The analysis for the first two research questions used individual-level data from each country, to explore differences between men and women *within* societies. Analysis for the third research question proceeded at the country level, focusing on variation between societies in the size of the gender difference in adult numeracy.

Chapter 3 focused on comprehensively describing gender differences in adult numeracy. The descriptive analysis compared gender differences in adult numeracy across age groups and skill levels, as well as highlighting the quantitative and substantive magnitude of the differences observed.

Key finding 1: ***Gender differences in adult numeracy are quantitatively small, but important and highly variable across age groups, societies, and skill levels***

The analysis showed that gender differences in adult numeracy are quantitatively relatively small, particularly when compared to differences based on other characteristics such as socio-economic background and being a first- or second-generation immigrant. However, in most countries, gender differences in adult numeracy are larger than gender differences in 15–year-olds' mathematical skills (as measured by the PISA study). Moreover, gender differences in adult numeracy are likely to have real consequences for individuals' life chances, due to the inferred loss of income associated with having lower numeracy skills. The findings therefore underscore the argument that gender differences in adult numeracy are a distinctive and important phenomenon.

The results further suggested that early adulthood is an important period in the life course within which to search for explanations. This provided the motivation for examining gendered experiences of further and higher education, which typically take place in the post-adolescent period, as potential explanations. The finding that gender differences were most pronounced in older adults in most countries suggested that it would also be important to investigate country-specific cohort effects relating to gendered experiences of education. However, this age-related pattern was not seen in all countries, suggesting that other explanations might also be important.

Chapter 3 confirmed that men are over-represented at the top of the numeracy performance distribution in almost all countries. This reflected the findings of numerous previous studies of adolescents and children, suggesting that this may be a consistent phenomenon internationally, across the life course, and in different generations. This also showed that distributional differences, including both across country-specific distributions and at PIAAC international benchmarks of low and high performance, are not always reflected by mean differences and are highly variable across countries. It is therefore important to analyse gender differences at different levels of numeracy skills and to explore the explanations of these differences. Overall, the findings of Chapter 3 suggest that population average differences obscure complex, country-specific age group and distributional patterns in the gender difference in adult numeracy, which were worthy of further investigation in the subsequent chapters.

Chapters 4 and **5** moved beyond the descriptive, applying techniques of statistical estimation and inference, primarily regression modelling. These chapters used individual-level data from the PIAAC background questionnaire to examine how gender differences in numeracy at different skill levels were affected by accounting for key variables that may be expected to 'explain' the difference.

Chapter 4 focused on answering the second broad research question: how are gender differences in adult numeracy related to gender-differentiated educational experiences? It sought to assess the evidence in the argument that gender differences in numeracy and related skills can be explained by gender inequalities in education (a variant of the gender stratification hypothesis).

Key finding 2: ***The relationship between gendered experiences of education and gender differences in adult numeracy is highly complex, age- and country-specific, and not always consistent with theoretical expectations.***

The chapter uncovered mixed support for the gender stratification hypothesis. The contrast in the gender difference in adult numeracy between the older and younger age group in many countries was attenuated by accounting for educational attainment, suggesting that the equalisation of education over time could partly explain this contrast. In general, educational exposures are relevant for older adults in most countries but less important as an explanatory factor among younger adults. This was particularly the case among older adults in the Netherlands, Germany, Korea, and Japan, where gender differences in adult numeracy were substantially and significantly reduced when controlling for educational attainment. However, in other countries, such as Finland, Norway, and Sweden, educational attainment had no explanatory power, even among the older generation. We can conclude from these findings that gender inequalities in education are only associated with gender differences in adult numeracy in certain, highly unequal countries and cohorts, and the equalisation of educational attainment over time has not necessarily led to a substantial reduction in gender differences in adult numeracy. The fact that more men than women study numerate fields in further and higher education partly explains the gender difference in adult numeracy, although its role is highly variable across countries. Moreover, differences in adult numeracy remain, both on average and at low and high skill levels, when controlling for educational factors. In most countries, individual education level and field do not explain a large proportion of the gender difference in adult numeracy.

Gender differences in adult numeracy were therefore not completely 'explained by' education, as it was measured in Chapter 4. This underscores the ambivalent role of education in relation to adult numeracy. It also reflects the results of previous studies which highlight the importance of considering other factors in adult life as important contributors to adult skills, beyond education (Bynner & Parsons 1998, 2009).

Focusing on working adults, **Chapter 5** addressed the third research question, by analysing the extent to which features of men and women's occupations may be related to their relative levels of adult numeracy. The chapter focused on the use of numeracy skills in the workplace within individual occupations, developing a novel empirical approach to measure occupational numeracy-intensiveness using data from the Job Requirements Approach module of the PIAAC background questionnaire.

Key finding 3: ***Women's participation in the labour market is not enough to guarantee equal levels of adult numeracy; they must also be able to access occupations that use numeracy skills.***

The results suggested that classifying occupations in terms of their numeracy-intensiveness adds further depth to the analysis of gender segregation in employment in cross-national perspective. In many countries, women are more likely than men to work in the least numeracy-intensive occupations. Women's service sector occupations are often low in numeracy-intensiveness; in some countries, this can partly explain gender differences in adult numeracy. Segregation by numeracy-intensiveness was not evident at all in post-Soviet countries, where women often work in numeracy-intensive occupations in business and finance, while men dominate in manual occupations that are low in numeracy-intensiveness. The results suggest that segregation in employment is an important factor to consider in order to understand the persistence of gender differences in adult numeracy in cross-national perspective. It is more variable across countries than other forms of gender segregation in employment, and, where it is pronounced and combined with industry-level segregation, represents a partial determinant of gender differences in adult numeracy. However, numeracy-intensiveness of occupations was not a systematic or overwhelmingly strong influence on gender differences in adult numeracy.

Having completed the individual-level analyses in chapters 4 and 5, it was clear that gender differences still remained when controlling for individual-level variables. This suggested the likelihood that either unmeasured factors or country context could be implicated in producing a gender difference in adult numeracy that was still larger in some countries than others. **Chapter 6** used methods of cross-national comparative analysis to explore variation in the gender difference in adult numeracy across 16 countries. The country-level outcomes used in this chapter to represent 'the gender difference in adult numeracy' were the residual gender differences from the previous chapters, i.e. the portion of the original gender differences that were left unexplained when controlling for individual-level variables. The chapter used the multivariate, exploratory technique of cluster analysis to identify distinctive profiles of gender relations. These clusters were then used as a key 'explanatory variable' in relation to cross-national variation in gender differences in adult numeracy. Five clusters were identified. These clusters all illustrated combination of egalitarian and inegalitarian features, showing the multidimensionality and complexity of gender relations in the post-industrial societies considered in this thesis.

Key finding 4: ***There is no obvious empirical relationship between 'gender inequality', conventionally conceived, and the gender difference in adult numeracy. In contrast, gender differences in adult numeracy are larger in societies that are more 'egalitarian' on conventional measures, such as female labour force and educational participation, and egalitarian gender culture (specifically, Nordic countries, where differences were particularly prevalent among young adults).***

The multidimensionality of gender relations was important to explaining gender differences in adult numeracy cross-nationally. The combination of egalitarianism and segregation (in Nordic counties) was associated with a larger gender difference in adult numeracy, whereas in more traditional societies (both with and without this segregation by numeracy intensiveness), gender differences were smaller (the Post-Soviet and East Asian countries). The results suggest that the combination of egalitarianism and segregation gives rise to gender differences in adult numeracy. Overall, the results in Chapter 6 contradict many of the ideas put forward by previous studies, by suggesting that empowering women may not necessarily lead to equal numeracy skill levels between men and women.

7.3 Implications

Based on the findings, a further aim of the thesis was to suggest potential actions that could be implemented to reduce gender differences in adult numeracy. Explanations for the gender difference in adult numeracy were revealed to be quite country-specific. Therefore, in terms of policy and practice, it seems that there are no universal recommendations that would automatically reduce the differences. Nonetheless, the following paragraphs make some preliminary suggestions regarding how policy and practice could be directed to solve the problem of gender differences in adult numeracy.

Overall, gender differences in educational attainment could not provide a systematic explanation for gender differences in adult numeracy across countries. However, educational differences between men and women do seem to be important among older adults in countries such as Germany, Japan, Korea, and the Netherlands. The fact that older women in these countries are less educated and less skilled in numeracy is important because of its implications for ageing and retirement. Research increasingly suggests that successful ageing is dependent on individuals' 'cognitive reserve' of education, cognitive and non-cognitive skills built up throughout the life course (Stern 2002; Whalley et al. 2004; Richards & Deary 2005). Therefore, one potential solution to tackling gender differences in adult numeracy in older generations could be to increase access to adult learning or other skill development activities, with a particular focus on gender equity.

Among younger adults, gender differences in adult numeracy are prevalent, even among men and women with the same education level. The findings therefore suggest that factors *within* education are likely to be important for explaining the gender difference in adult numeracy. Much attention has been paid to encouraging more women to participate in STEM education, and this may be important for encouraging equal levels of numeracy skills. However, there could also be more subtle forms of segregation and discrimination which prevent women from emerging from education with adequate numeracy skills. For example, studies have noted marked gender differences in pathways through further and higher education (Smyth 2005), in motivation and attitudes towards numerate and STEM subjects (Schoon & Eccles 2014), and in career goals (Cech 2013; Morgan et al. 2013). Much of the policy activity in this area has been focused on encouraging girls to change their attitudes and preferences. While this thesis cannot speak directly to what the most successful strategies are, I would suggest that the solution lies with encouraging desegregation and attitude change from both sides, for example, by encouraging boys to take up more traditionally feminine (and often less numerate) specialisms and making all educational environments more gender-neutral.

Chapter 5 suggested that labour market segregation, particularly the separation of men and women into jobs that involve more or less numeracy-intensiveness, is a clear problem in some countries. In these countries, it can partly explain why women tend to have lower numeracy skills than men, particularly when viewed alongside industry-level gender segregation (particularly the female domination of social services sector jobs) and other aspects of gender relations analysed in Chapter 6. The question then becomes: how to get more women into numeracy-intensive occupations, particularly in the Nordic and East Asian countries? The solution to this is complex and depends on one's theoretical perspective on segregation. A culturalist perspective would suggest that we need to increase women's preference for numeracy-intensive occupations. However, this solution is not very optimistic. Proponents of this culturalist perspective, such as Charles and Grusky, suggest that essentialist preferences are so deeply held by individuals and so embedded in liberal egalitarian ideology that it would take a fundamental change to that whole ideology to shift them (Charles & Grusky 2011) - a 'second revolution' to establish a new, broader definition of equality (Charles & Grusky 2011: 340).

From another perspective, the problem is more structural and therefore amenable to policy and legal intervention. The male domination of numeracy-intensive occupations could be an example of patriarchy rather than the result of essentialist preferences. Patriarchy operates partly though men excluding women's access to economically productive resources. There are many ways this operates including through employers' hiring decisions, direct discrimination, and workplace culture. The fact that gender segregation on the basis of occupations' numeracy-intensiveness is prevalent in a country such as Japan, which is considered highly 'traditional' and 'patriarchal' in its gender relations, rather supports this interpretation, even though it is also present in egalitarian contexts such as the Nordic countries. From this perspective, women are not *choosing* less numeracy-intensive jobs; rather, they are being allocated to these jobs via biased, discriminatory structural processes (Reskin & Padavic 1994).

From this perspective, the solution would be to remove the patriarchal domination of the most numeracy-intensive occupations and to alter the surrounding organisational cultures, which would appear to be present in both 'egalitarian' and 'traditional' societies. For example, research in Japan suggests that gender-discriminatory organisational cultures are extremely entrenched (Nemoto 2013a, 2013b. However, this is also the case in relatively egalitarian contexts. Acker's theory of 'gendered organisations' (Acker 1990, 2006) has been empirically evidenced across a range of supposedly egalitarian contexts (e.g. Cook & Glass 2014). There are many examples of effective integration policies – for example, positive discrimination, segregation, and hiring audits (Bettio et al. 2009) - which could also eventually result in organisational culture change.

A final suggestion, as an alternative to desegregation strategies, is to alter the content, skills profile, and valuation of female-dominated social services occupations. As these types of occupations become more dominant in post-industrial societies, this is an important matter. Skills use is an intrinsic aspect of job quality, which should be evenly distributed. Multiple studies have documented processes of devaluation that take place when occupations become female-dominated (England 2005; Levanon et al. 2009; Busch 2018). Policy responses to this include the provision of more on-the-job training to women in segregated occupations, as well as the formal re-valuation of occupations in order to combat informal devaluation (Bettio et al. 2009). These strategies may also be important to enable women to access more numeracy-intensive working environments, and to set precedents for skill requirements for upcoming generations.

7.4 Outlook

As a result of this study, further research should be conducted into three key areas: (1) the links between configurations of gender relations and gendered outcomes in the broader STEM sphere, (2) the mechanisms linking segregation and gender differences in numeracy, including a variety of research designs and approaches, and (3) the consequences of gender differences in adult numeracy.

(1) Further research on the links between configurations of gender relations and gendered outcomes in the broader STEM sphere.

The theoretical framework and empirical analysis presented in this thesis suggest that conceptualising gender relations as a configuration, rather than as a linear measure on which countries are more or less 'equal', could be a fruitful approach for future studies on gender and mathematical, numerical, and STEM skills and attitudes. This approach allows us to distinguish between countries that are apparently similar in terms of their level of economic development and the level of integration of women into social and economic life. It also allows us to question the place of some countries in the rankings created by linear measures of gender inequality.

Viewing countries' gender relations as a configuration reveals that countries can exhibit both egalitarian and inegalitarian features. The thesis therefore provides further empirical validation of the approach instigated by scholars such as Connell (1987) and Mandel (2009) which could be applied to broader samples of countries in future research. It would be particularly interesting to extend the analysis to include Middle Eastern and Gulf countries. In previous research, countries in this region provided an interesting counter-case: highly unequal in terms of gender more generally, but showing minimal gender differences in mathematical skills, which authors suggested may be due to the existence of single-sex schooling (Fryer & Levitt 2010; Kane & Mertz 2012).

My analysis found that gender differences in adult numeracy were less pronounced in countries that exhibited highly inequitable gender relations, such as East Asian and post-Soviet countries. Yet these countries are very different in terms of history and culture. Potential commonalities between countries that are relatively unequal and traditional in terms of gender relations but which, paradoxically, limit gender differentiation of numeracy and related skills is a promising area for future research. This could be addressed in terms of culture, the structure of the education system, and patterns of gender segregation in employment.

(2) Further research to understand the mechanisms linking segregation and gender differences in skills

Across the thesis, it appeared that gender segregation was more important than gender stratification, or vertical inequality, for explaining gender differences in adult numeracy. This was the case in both educational and work domains. However, further questions were raised about how this segregation operates to create gender differences in adult numeracy. For instance, Chapter 4 raised important questions about the relationship between education and gender differences in adult numeracy. It should be acknowledged that the chapter only provided a partial operationalisation of gender differences in educational experiences. For example, institutional settings which provide prescribed routes through the education system may be important to consider. Adult education, in which there are demonstrated gender differences in the level and type of engagement (Dämmrich et al. 2015), may also be important. These areas could be addressed in future research through further comparative and longitudinal study of education policies, their segregating effects on gendered educational experiences, and their long-term effects on gendered patterns of skill development.

Although the analysis in Chapter 5 was detailed with regard to the characteristics of occupations, information on more intricate aspects of employment and workplace interaction would be invaluable to elaborate on the links between employment segregation and gender differences in adult numeracy. Analysis using longitudinal data to explore individuals' progress through careers and the associated impact on skills would also be highly revealing. Recent examples of such approaches include Boye and Grönlund (2018), which examined the skills content of early career occupations and later implications for the gender difference in earnings. If data were available, a similar approach could be used to study occupational exposures in the early career and their impact on later gendered skills outcomes.

The post-Soviet countries emerged as a very distinctive case within this study. Gender differences in numeracy were persistently low across the different samples considered (although there were some notable differences at distribution extremes). An ambivalent gender culture, and an absence of gender segregation in employment on the basis of numeracy-intensiveness were common features in these countries. Literature on women's employment in Soviet and post-Soviet societies offers some insight into these findings. While socialist societies were certainly not a utopia for women, the Soviet full employment ideology and opportunities in sectors of employment that were male-dominated in most other societies were positive for women's occupational and economic achievements (Kosyakova et al., 2015, 2018) and this may have had a positive impact on women's numeracy skill levels. For example, under socialism, while men retained over-riding monopoly over status and power, women were defined primarily as workers. Due to labour shortages, women also had more opportunities to enter certain industries, such as medicine and accountancy. They also commonly worked in accountancy and clerical jobs within state infrastructure, and had an important role in the informal, barter economy (Gal & Kligman 2000). These trends may have influenced the adult numeracy of current generations of adults who lived under socialism. A recent study suggests that these trends were also very important for the formation of norms regarding female employment, which have had an impact on gendered skills outcomes in later generations (Lippmann & Senik 2016). In contrast, younger generations growing up under economic liberalisation have experienced resurgent gender inequalities in the labour market (Kosyakova et al. 2015, 2018). Future research could pursue a historical case study approach to analysing the links between the characteristics of socialist and post-transition societies and adult skills outcomes of men and women in different generations, informed by scholarship on the relationship between socialism, gender and the post socialist transition, such as Gal and Kligman (2000) and Kosyakova et al. (2015, 2018)

(3) Further research on the consequences of gender differences in adult numeracy

The present study has identified that gender differences in adult numeracy are a problem and has explored potential explanations but has not focused on the consequences. Although some research suggests that gender differences in adult numeracy directly influence the gender pay gap (Hanushek et al. 2015), further research should be conducted to explore the broader implications for career development, lifetime earnings, and outcomes such as health, wellbeing, and civic participation. This research could compare women's outcomes in countries where there is little difference in adult numeracy (such as post-Soviet countries) and countries where the difference is pronounced. This would clarify the extent to which broader inequalities would be mitigated if adult numeracy was evenly distributed between men and women. Finally, future research could explore the role of factors that have not been considered in this thesis, such as assessment design and testing environment, which could be important determinants of how gender differences are expressed (Ball et al. 2013).

7.5 Limitations

Data limitations

The first limitation of this thesis is common to many studies based on secondary data analysis. The analysis is constrained by the data that has been collected by the OECD. Decisions made by the OECD affect the level of generalisation, the variables chosen, and the units and levels of analysis. The first and most obvious way this has affected the findings is through the selection of countries. This poses a number of problems for both analysis and interpretation.

The relatively small number of countries was one reason for the selection of analytical methods. I opted for a two-step approach, which decomposes individual-level and country-level analysis into two stages. This is an alternative to a more typical, multilevel framework, which is problematic when the number of countries is relatively low, in that the statistical power to detect differences between countries is constrained (Bryan & Jenkins 2016). While dealing with the low N problem, this approach also has inherent strengths, namely a focus on variation across countries in individual-level relationships (which are often subsumed in a multilevel approach), and the close fit with the theoretical framework, which conceptualised gender relations as operating at the individual and collective level. Secondly, the relatively low N was one reason for the selection of cluster analysis as a technique to find profiles of gender relations among countries (instead of a model-based technique such as Latent Class Analysis, which requires more data points).

However, while I used the small N to my advantage through these techniques, its problematic aspects should also be acknowledged. Firstly, due to the small sample of countries, there is less variation than would be ideal, and relatively few variables can be included in the Chapter 6 models simultaneously. The small N within countries is also an issue for the individual-level analysis: country samples in PIAAC are nationally representative but are not very large. This limits the multivariate analysis that can be done because of sample size limitations. For example, I had hoped to conduct quantile regression to assess gender differences at high and low numeracy levels, but due to the relatively low numbers of individuals in the lower and upper quantiles, coupled with the complex estimation procedures needed to avoid bias in analysing the PIAAC data, models would not converge.

Generalisation and causal inference

A further concern associated with the countries available for analysis is in the generalisability of the findings. In theory, comparative research allows one to get closer to the experimental method, in that one implicitly suggests a counterfactual situation when comparing countries. The countries where a certain social phenomenon is absent provide 'controls', allowing a researcher to compare values of the outcome when the phenomenon is present and when it is absent. However, in practice, and especially with cross-sectional survey data from a limited number of countries, truly generalisable, causal inference still remains hard to reach.

The first reason for this is that causal inference generally relies on the chosen data being a randomly selected sample of a known population. While the samples within each population were randomly selected, and results can thus be generalised to the country as a whole, the cross-country analysis, in Chapter 6, relies on countries as its data points. These countries have not been randomly selected. If different countries, and greater numbers of countries, had been included, the conclusions may have been different. It is therefore unclear to what population the results should be generalised. Some authors have suggested that cross-national comparative research should make inferences to a 'conceptual super-population'; however, the issue is far from resolved in the methodological literature (see Bryan & Jenkins 2016).

Another constraint relating to generalisability is that countries may not represent fully independent entities in the way that is formally required for statistical inference. In the past, countries could more plausibly be viewed as distinct entities, but in the current globalised world, in which there is arguably ‘a highly institutionalised world polity’ (Meyer 1987: 42), this assumption is less realistic. The countries’ membership of the OECD is a clear signifier of their interdependence, since member countries share values, goals, and institutional arrangements. This lack of independence of observations is a major line of critique levelled at variable-based comparative research by proponents of case-based comparative methods (Ragin 2014).

A further problem associated with causal inference in comparative research is the ‘black box problem’ (Goldthorpe 2001). That is, observing an association between two variables in a cross-country analysis does not reveal anything about the social processes underlying the relationship, and therefore raises more questions than it answers. Independent relationships between variables are difficult to distinguish when there are multiple intercorrelations between possible predictor variables. This means that there are always competing explanations for the relationships observed, and multiple possible causal pathways that cannot be accounted for. Goldthorpe (2016: 113–114) suggests that this vagueness of causal mechanisms is not strictly an empirical or technical problem, but primarily a ‘sociological and theoretical one’. In Goldthorpe’s view, researchers need to (a) provide plausible causal narratives that might underlie any associations observed and (b) suggest viable research strategies through which these potential causal mechanisms could be tested empirically. Throughout the chapters, I have provided such causal narratives and in this conclusion I suggest empirical strategies to test these narratives in future research (in section 7.4).

Lack of longitudinal data

The cross-sectional nature of the PIAAC data represents a number of problems beyond the fact that it limits the number of observations available. Firstly, due to the absence of prior measures of numeracy skills or general ability, it is not possible to comment definitively on the direction of any relationships observed. For example, it is entirely possible that individuals with higher numeracy skills self-select into certain occupations, as opposed to a situation where the distribution of individuals across occupations induces variation in numeracy skills. At the country level, it could be that gender differences in numeracy cause patterns of segregation, rather than the other way around, which would suggest that labour markets have adapted and developed to the qualities of the labour supply. These alternative causal directions cannot be ruled out empirically. The absence of prior skill measures is also a problem conceptually, given that the development and maintenance of cognitive skills is viewed as a life course phenomenon, yet skills proficiency is only observed at a moment in time.

The cross-sectional nature of the PIAAC data is addressed to some extent by the inclusion of control variables that are likely to be strongly related to skill development across the life course and can therefore account for some of the variance between individuals that is not captured by the PIAAC assessment scores themselves. However, across the thesis, it is not possible to ascertain definitively the direction of any relationships observed. Although this is a drawback, it is mitigated somewhat by the nature the PIAAC data: its high quality, direct measures of adult numeracy, relatively high response rates, and low levels of missing data.

Imperfect measures of concepts

There are no other recent, cross-national studies of adult numeracy with the scope and coverage of PIAAC. If one wishes to study cross-national variation in the gender difference in numeracy, one must therefore accept the PIAAC definition and measurement of numeracy. However, I do acknowledge the various flaws associated with the way numeracy is measured in PIAAC, not least its cultural specificity, and its limited range of response styles, which may not capture the numeracy skills of all participants (Morris 2015; Tsatsaroni & Evans 2014). I would submit that these drawbacks are addressed to some extent by the fact that the skills measures were developed by world-renowned experts in educational assessment over a long process, as well as by strong evidence of associations between these skills and outcomes that really matter for individuals and societies, such as income and economic inequality.

In the cross-country analysis in Chapter 6, selected indicators of gender relations are applied to whole countries as average or summary measures. The selection of indicators depended on the data that were available for all countries in the sample. This is obviously limiting, since selected variables aggregated to the country level are very likely to be an over-simplification of the complex reality. This problem has been addressed to a certain extent by using a multivariate, exploratory method where the focus is on cases and their features, rather than on variables (cluster analysis), and by an explicit focus on country cases and the level of heterogeneity or homogeneity within clusters, stressing the limits of generalisation. Yet, the literature shows that, for example, gender role attitudes, used as indicators of national gender culture, can be highly diverse within populations, such as between genders, or those with different levels of education (McDaniel 2008; Knight & Brinton 2017). Moreover, indicators of gender relations have only been selected from one point in time. Aggregation of data from a single time point to the country level therefore neglects crucial detail within populations as well as change over time. In future research, this could be addressed by calculating attitudinal measures that separately represent male and female populations, as well as constructing indicators that measure aspects of gender relations for particular groups of women, for example, employment among mothers versus non-mothers, as well as considering generational or within-population change.

7.6 Contributions

This thesis makes several important contributions, despite the limitations mentioned. The first major contribution is new empirical analysis which adds to two growing literatures: one on inequalities in adult skills, based on PIAAC; and one, already large, literature on gender and cognitive skills in cross-national perspective. Trends and patterns in gender and education are of great interest to researchers, policy makers and the general public. Evidence on how gender differences in numeracy are realised among adults in a range of countries is therefore a welcome addition to this body of knowledge.

The second major contribution of this thesis is to the literature on the relationship between gender inequality and gender differences in numeracy and related skills. The findings of the thesis largely diverge from the arguments of the gender stratification hypothesis, which have been supported by recent studies (e.g. Guiso et al. 2008; Gevrek et al. 2018; Rodríguez-Planas & Nollenberger 2018). These studies claim that empowering *women* and girls will lead to the equalisation of numeracy skills. Instead, the findings of this thesis are more congruent with an alternative set of studies (e.g. Goldman & Penner 2014; Charles et al. 2014; Stoet & Geary 2015; Charles 2017), which find that the relationship between gender inequality and gender differences in numeracy is more nuanced, representing something of a paradox. Similarly, this study shows that, although aspects of empowerment may have been important in equalising the numeracy skills of older generations, among adult across the age range, there are other aspects of gender relations to consider. Both education and the workplace may be important arenas for reinforcing and maintaining gender differences in adult numeracy at the individual level.

While other studies have focused on individual psychological attributes, such as attitudes and anxieties as possibly reinforcing gender differences in skills in gender-egalitarian contexts, I suggest that structural issues, especially labour market segregation, and the multidimensionality of gender relations, are likely to be equally, if not more, important. For example, the combination of egalitarian trends and attitudes, along with segregation in employment, appears to reinforce gender differences among young adults (in the Nordic countries). My multidimensional, micro-macro framework was key to revealing these intricacies and suggests that the concept of gender relations is a more useful way to understand how gender differences in skills are perpetuated. The statement that 'policy initiatives aiming at bolstering female empowerment could serve as powerful tools to improve girls' mathematics achievement' (Gevrek et al. 2018: 20) is likely to be far too simplistic. Gender differences in adult numeracy are a complex issue that is not easy to explain in contemporary industrialised societies, in which the nature of 'gender equality' is highly ambivalent and multidimensional.

Thirdly, the analysis contributes further evidence on a problem that has been repeatedly highlighted by previous research – the low intrinsic job quality of women's occupations (e.g. Glass 1990; Stier & Yaish 2014; Boye & Grönlund 2018). In the Nordic countries, Japan, and Korea, I found that large proportions of women work in occupations that are low in numeracy-intensiveness. However, this form of labour market segregation was entirely absent in the post-Soviet countries. The thesis has therefore uncovered an important aspect of variation between societies in terms of the character of gender segregation in the labour market, which has been largely overlooked until this point.

Finally, with its integrative micro-macro framework, this thesis draws together diverse literatures and methodological approaches, referencing insights from life course research on the determinants of skills in adult life, as well as integrating feminist theory of gender relations. Although gender differences in skills have been widely studied in relation to gender inequality, this has rarely been approached from a feminist standpoint, which integrates the multiple definitions, levels, and dimensions of gender inequality in contemporary societies. Moreover, exposures and experiences in adulthood are likely to be very important for gender differences in adult numeracy skills, yet this has rarely been acknowledged in research to date. I developed an empirical strategy which operationalised this novel outlook. As such, this approach provides a useful framing for understanding gender differences in educational and employment outcomes which can be taken forward in future research and will be useful to scholars across a range of disciplines including comparative sociology, comparative education, research on life-long learning, and gender studies.

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Appendix

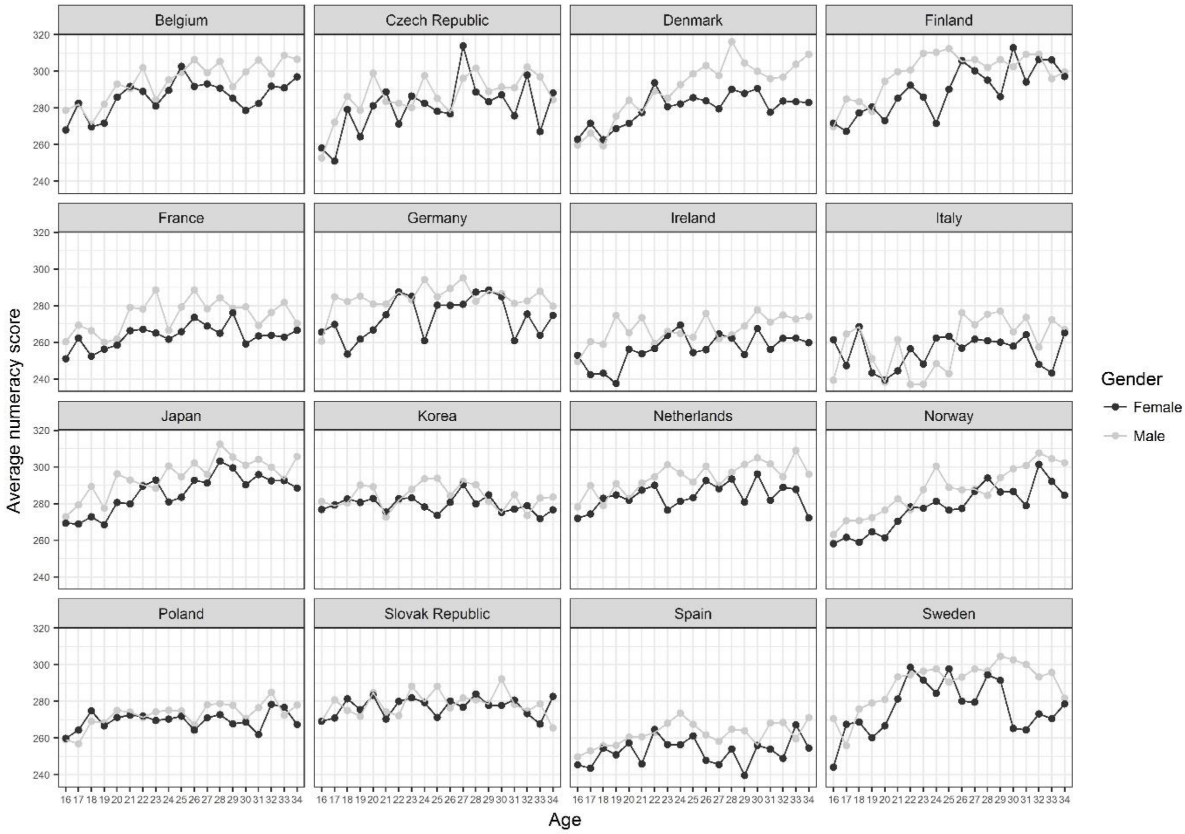
APPENDIX TO CHAPTER 3

Table A3.1 Earnings returns to adult numeracy

Country	Coef (SE)
Austria	0.18 (0.01)
Belgium	0.15 (0.01)
Canada	0.19 (0.01)
Czech Republic	0.12 (0.02)
Denmark	0.14 (0.01)
Estonia	0.18 (0.01)
Finland	0.14 (0.01)
France	0.17 (0.01)
Germany	0.24 (0.01)
Ireland	0.24 (0.02)
Italy	0.13 (0.02)
Japan	0.18 (0.01)
Korea	0.22 (0.01)
Netherlands	0.18 (0.01)
Norway	0.13 (0.01)
Poland	0.19 (0.02)
Slovak Republic	0.18 (0.02)
Spain	0.23 (0.02)
Sweden	0.12 (0.01)
United States	0.23 (0.01)
England/N. Ireland (UK)	0.28 (0.02)

Source: Hanushek et al. (2015) Table 2. Results from OLS regression using sampling weights. Dependent variable: log gross hourly wage. Sample: full-time employees aged 35–54 (Canada includes part-time employees). Numeracy score standardized to std. dev. 1 within each country. Experience2 divided by 1000. Robust standard errors in parentheses. Results have been rounded to two decimal places.

Figure A3.1 Male and female average numeracy score by age, adults aged 16-34, 2012



APPENDIX TO CHAPTER 4

Table A4.1 Average years of education by gender and age group

	25-34-year-olds				55-64-year-olds			
	Women		Men		Women		Men	
Country	mean	S.E.	mean	S.E.	mean	S.E.	mean	S.E.
Belgium	13.66	0.11	13.12	0.12	11.18	0.14	11.72	0.14
Canada	14.21	0.06	13.59	0.08	12.89	0.08	13.09	0.09
Czech Republic	14.29	0.13	13.46	0.11	12.34	0.1	13.22	0.12
Denmark	13.85	0.12	13.17	0.12	12.32	0.09	12.56	0.09
Estonia	13.18	0.1	12.14	0.11	12.28	0.09	11.6	0.11
Finland	.	.	.	.	.	.	.	.
France	12.79	0.14	12.42	0.13	9.75	0.12	9.82	0.12
Germany	14.06	0.11	13.77	0.11	13.14	0.11	14.28	0.09
Ireland	15.91	0.08	15.61	0.07	12.84	0.11	12.63	0.14
Italy	13.14	0.2	12.19	0.24	8.26	0.2	9.05	0.27
Japan	13.63	0.1	13.68	0.11	11.87	0.08	12.84	0.1
Korea	14.72	0.09	14.26	0.07	9.32	0.12	11.11	0.13
Netherlands	.	.	.	.	.	.	.	.
Norway	15.02	0.09	14.34	0.12	13.69	0.12	14.12	0.12
Poland	14.48	0.13	13.7	0.14	11.69	0.12	11.28	0.13
Slovak Republic	14.02	0.14	13.57	0.11	12.39	0.12	12.72	0.11
Spain	12.82	0.12	12.03	0.14	9.59	0.15	9.93	0.16
Sweden	12.88	0.1	12.46	0.08	11.76	0.06	11.59	0.07
United States	14.02	0.11	13.55	0.13	13.45	0.1	13.8	0.14
England/N. Ireland (UK)	13.53	0.09	13.48	0.09	12.75	0.11	12.87	0.1

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Years education variable not available for Finland and Netherlands.

Table A4.2 Alternative analysis with years of education (OLS models)

	25-34-year olds				55-64-year olds			
	Model 1		Model 2		Model 1		Model 2	
Country	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Belgium	9.91***	3.35	15.61***	3.12	19.42***	3.59	15.55***	3.29
Canada	12.81***	2.63	18.48***	2.52	19.59***	2.59	17.21***	2.46
Czech Republic	5.58	3.98	12.89***	3.60	2.8	4.35	-3.58	3.86
Denmark	16.85***	3.25	21.54***	3.12	13.61***	2.14	11.68***	1.98
Estonia	9.16**	3.06	17.03***	2.86	-0.71	2.27	4.29	2.24
Finland	6.42**	3.01			10.17***	3.14		
France	8.86**	2.71	13.16***	2.27	12.74***	2.82	11.29***	2.68
Germany	7.19**	3.24	9.72***	3.26	26.09***	3.93	15.32***	3.66
Ireland	11.44***	3.37	13.64***	3.08	14.01***	4.33	14.74***	3.79
Italy	11.34***	4.37	16.66***	3.85	12.45***	3.97	7.86*	3.66
Japan	9.79***	3.01	9.01*	2.85	14.01***	3.32	5.74	3.12
Korea	4.93*	2.23	7.60***	2.27	21.43***	3.16	9.13**	2.73
Netherlands	10.75***	3.53			18.94***	3.16		
Norway	12.14***	3.03	17.76***	2.86	16.98***	3.57	15.74***	3.27
Poland	4.93	3.1	10.34***	3.11	3.23	3.59	5.60	3.57
Slovak Republic	0.95	2.99	6.07*	2.77	-2.55	2.9	-5.25	2.77
Spain	8.42**	2.8	14.51***	2.67	17.37***	3.18	15.23***	2.82
Sweden	12.17***	3.48	16.90***	3.35	16.77***	3.02	17.47***	2.98
UK	14.03***	3.8	13.87***	3.84	19.37***	3.48	16.29***	3.84
USA	13.59***	3.49	21.09***	3.45	18.61***	4.01	16.38***	3.45

Note: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values. *$p < 0.05$, * $p <0.01$, ** $p <0.001$,**** . Model 1 regresses adult numeracy on gender, immigrant status, parental education. Model 2 = Model 1 + years of education. Years of education not available for Finland and Netherlands.

Table A4.3 Educational attainment, 25-34 year olds in PIAAC 2012

	Women									
	Lower than upper secondary		Upper secondary		Post-secondary (non-tertiary)		Tertiary		Total	N
	%	SE	%	SE	%	SE	%	SE		
Belgium	7.44	1.1	32.39	2.35	4.28	0.92	55.89	2.38	100	449
Canada	7.04	0.83	17.14	1.1	13.52	1.2	62.3	1.37	100	2580
Czech Republic	5.48	1.24	54.41	2.35	1.59	0.48	38.52	2.17	100	754
Denmark	12.6	1.83	27.33	2.37	1.57	0.59	58.5	2.52	100	497
Estonia	12.04	1.26	26.35	1.8	6.4	0.81	55.22	1.82	100	738
Finland	5.31	1.13	46.04	1.99	0	0	48.65	2.13	100	511
France	13.44	1.42	40.61	2.03	0	0	45.95	2.04	100	606
Germany	17.17	2	56.2	2.07	3.04	0.72	23.59	1.71	100	501
Ireland	10.91	1.02	18.48	1.49	19.81	1.66	50.79	1.56	100	777
Italy	22.58	2.53	48.59	2.79	1.48	0.81	27.35	2.23	100	389
Japan	7.63	1.55	31.56	2.26	1.45	0.58	59.36	2.17	100	485
Korea	2.04	0.67	29.2	1.8	0	0	68.76	1.83	100	615
Netherlands	16.47	1.95	39.8	2.6	0	0	43.72	2.48	100	433
Norway	13	1.45	25.62	2.18	6.96	1.33	54.43	2.08	100	430
Poland	3.25	0.87	37.21	2.03	6.75	1.21	52.8	2.35	100	1054
Slovak Republic	11.43	1.4	55.08	2.21	0.98	0.29	32.51	2.2	100	609
Spain	28.23	1.86	23.84	1.53	2.35	0.64	45.57	1.89	100	591
Sweden	12.51	1.71	33.92	1.87	8.81	1.43	44.76	1.75	100	396
UK	17.67	1.69	33.74	2.08	0.5	0.25	48.09	1.96	100	1084
USA	9.54	1.02	32.3	2.38	10.74	1.68	47.42	1.93	100	570
	Men									
	Lower than upper secondary		Upper secondary		Post-secondary (non-tertiary)		Tertiary		Total	N
	%	SE	%	SE	%	SE	%	SE		
Belgium	7.84	1.33	48.91	2.46	3.26	0.89	39.99	2.48	100	404
Canada	9.03	1.08	23.35	1.51	14.93	1.38	52.7	1.86	100	1994
Czech Republic	7.3	1.22	68.69	2.03	2.21	0.73	21.8	1.61	100	579
Denmark	12.76	1.9	42.86	2.63	2.42	0.78	41.96	2.41	100	433
Estonia	16.78	1.47	43.39	1.86	5.34	0.93	34.49	2.11	100	668
Finland	9.61	1.66	59.48	1.96	0	0	30.92	1.73	100	533
France	14.03	1.43	49.01	1.84	0	0	36.97	1.96	100	537
Germany	6.93	1.42	47.66	2.09	2.31	0.73	43.11	1.85	100	493
Ireland	16.02	0.99	22.18	1.48	21.2	1.74	40.59	1.76	100	620
Italy	33.25	3.09	45.11	2.74	0.75	0.47	20.89	2.11	100	361
Japan	8.56	1.49	35.93	2.14	2.01	0.71	53.49	1.99	100	433
Korea	2.32	0.6	40.65	1.47	0	0	57.03	1.46	100	618

Netherlands	21.14	2.19	41.39	2.81	0	0	37.47	2.77	100	368
Norway	19.56	2.12	33.97	2.3	9.99	1.49	36.47	2.09	100	441
Poland	6.35	1.21	48.98	1.95	2.92	0.68	41.75	2.01	100	999
Slovak Republic	12.01	1.18	62.81	1.97	0.52	0.29	24.67	1.83	100	591
Spain	39.39	2.11	24.48	1.95	1.87	0.59	34.26	1.84	100	554
Sweden	14.54	1.83	41.64	2.11	9.56	1.53	34.26	1.5	100	407
UK	15.41	1.69	35.84	2.45	0.14	0.15	48.6	2.12	100	718
USA	10.79	1.64	41.29	2.34	9.19	1.33	38.73	2.05	100	457

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied.

Table A4.4 Educational attainment, 55-64 year olds in PIAAC 2012

	Women									
	Lower than upper secondary		Upper secondary		Post-secondary (non-tertiary)		Tertiary		Total	N
	%	S.E.	%	S.E.	%	S.E.	%	S.E.		
Belgium	36.32	2.05	34.65	2.03	2.27	0.65	26.77	1.9	100	513
Canada	18.21	1.05	25.6	1.2	14.19	0.98	41.99	1.46	100	3,088
Czech Republic	27.87	1.96	57.82	2.32	2.59	0.65	11.72	1.41	100	788
Denmark	30.04	1.64	33.36	1.56	2.02	0.47	34.58	1.39	100	1,135
Estonia	11.93	0.89	37.97	1.53	6.84	0.79	43.26	1.62	100	993
Finland	25.22	1.6	59.87	1.94	0	0	14.91	1.24	100	726
France	43.37	1.61	38.28	1.44	0	0	18.35	1.13	100	766
Germany	17.17	2	56.2	2.07	3.04	0.72	23.59	1.71	100	506
Ireland	49.49	1.41	16.23	1.3	13.56	1.46	20.71	1.24	100	614
Italy	76.54	2.13	15.46	1.67	0.15	0.1	7.85	1.12	100	541
Japan	23.62	1.87	53.77	2	1.49	0.48	21.13	1.37	100	635
Korea	64.53	1.86	26.29	1.72	0	0	9.19	0.9	100	632
Netherlands	51.25	2.01	25.19	1.92	0	0	23.56	1.57	100	577
Norway	34.77	2.24	24.3	2.5	8.36	1.32	32.57	2.65	100	410
Poland	15.49	1.68	60	2.27	8.86	1.16	15.65	1.39	100	544
Slovak Republic	30.64	1.8	55.76	2.22	0.15	0.15	13.45	1.6	100	642
Spain	66.34	1.87	16.28	1.47	1.39	0.57	16	1.39	100	521
Sweden	32.25	1.5	32.33	1.49	6.33	1	29.09	0.93	100	500
UK	37.73	1.96	32.49	2.16	0.48	0.34	29.31	2.15	100	1,023
USA	10.02	0.77	45.16	1.75	9.66	1.29	35.16	1.59	100	589

	Men									
	Lower than upper secondary		Upper secondary		Post-secondary (non-tertiary)		Tertiary		Total	N
	%	S.E.	%	S.E.	%	S.E.	%	S.E.		
Belgium	27.62	1.97	42.6	2.2	2.77	0.72	27.01	1.85	100	511
Canada	18.62	1.15	21.88	1.21	15.08	1.13	44.42	1.4	100	2,817
Czech Republic	10.06	2.14	68.44	2.77	2.65	1.31	18.85	1.58	100	602
Denmark	21.39	1.5	46.17	1.53	1.87	0.5	30.57	1.44	100	1,133
Estonia	20.7	1.39	44.05	1.86	3.67	0.82	31.58	1.86	100	680
Finland	30.43	1.46	55.31	1.72	0	0	14.26	1.24	100	705
France	40.19	1.55	43.63	1.6	0	0	16.19	1.14	100	771
Germany	6.93	1.42	47.66	2.09	2.31	0.73	43.11	1.85	100	463
Ireland	51.01	1.67	18.9	1.66	11.46	1.31	18.64	1.5	100	500

Italy	68.36	3.46	22.5	2.82	0.6	0.45	8.55	1.33	100	448
Japan	19.64	1.53	42.58	1.8	1.25	0.48	36.53	1.8	100	617
Korea	41.06	2.07	36.26	2.09	0	0	22.68	1.07	100	549
Netherlands	37.75	2.14	31.82	2.21	0	0	30.42	1.93	100	645
Norway	27.25	2.21	19.74	1.98	17.06	1.67	35.95	1.96	100	476
Poland	17.2	1.72	65.64	2.24	1.59	0.77	15.57	1.63	100	450
Slovak Republic	22.33	1.68	61.68	2.17	0.78	0.48	15.22	1.49	100	502
Spain	59	2.01	19.18	1.88	1	0.35	20.82	1.9	100	484
Sweden	29.63	1.32	36.58	1.35	9.54	1.17	24.25	1.1	100	532
England/ N. Ireland (UK)	31.13	2.06	36.83	2.15	0.42	0.41	31.63	1.8	100	782
United States	10.98	1.12	40.06	2.18	7.57	1.3	41.38	2.3	100	455

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied.

Table A4.5 Fields of study in upper secondary and tertiary education, 25-34 year olds in PIAAC 2012

	Women																						
	General programmes		Teacher training and education science		Humanities, languages and arts		Social sciences, business and law		Science, mathematics and computing		Engineering, manufacturing and construction		Agriculture and veterinary		Health and welfare		Services		Missing - below upper secondary education		Missing		N
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	
Belgium	13.04	1.82	11.91	1.51	9.52	1.55	22.13	1.92	9.12	1.24	5.93	1.13	1.15	0.52	16.8	1.8	2.95	0.86	7.07	1.07	0.38	0.27	449
Canada	17.66	1.14	11.23	0.93	9.96	0.91	20.18	1.26	7.6	0.89	2.85	0.52	1.4	0.38	16.64	1.03	5.23	0.65	6.68	0.79	0.57	0.34	2580
Czech Republic	5	1.18	6.67	1.22	7.02	1.18	37.5	2.64	1.97	0.51	12.35	1.67	3.1	0.88	3.37	0.53	17.15	1.84	5.07	1.24	0.81	0.83	754
Denmark	9.14	1.42	11.8	1.45	10.24	1.12	15.76	1.53	6.82	1.22	4.99	0.94	1.69	0.58	21.75	2.04	11.39	1.67	6.42	1.24	0	0	497
Estonia	13.61	1.31	3.88	0.69	7.9	0.96	25.35	1.74	4.53	0.89	9.9	1.16	1.79	0.47	8.12	0.97	13.45	1.18	11.08	1.25	0.4	0.23	738
Finland	11.68	1.15	5.48	1.12	10.03	1.13	19.24	1.78	3.92	0.72	7.58	1.12	2.31	0.68	21.23	1.74	12.78	1.36	0	0	5.74	1.17	511
France	9.44	1.31	3.06	0.6	6.41	0.77	23.03	1.63	8	0.83	3.79	0.7	2.22	0.54	15.73	1.18	14.55	1.44	12.96	1.39	0.8	0.33	606
Germany	4.56	0.96	4.95	1.06	5.93	0.98	31.69	2.64	4.75	1.09	4.38	1	0.58	0.37	22.78	2.14	8.42	1.26	9.85	1.49	2.11	0.71	501
Ireland	4.9	0.82	9.82	1.11	8.62	1.23	18.9	1.39	8.54	1.05	1.91	0.58	0.62	0.34	10.47	1.05	6.83	0.96	10.91	1.02	18.48	1.49	777
Italy	6.35	1.24	5.55	1.42	23.05	2.41	14.56	1.94	15.32	1.86	1.81	0.7	1.76	0.8	3.84	1.17	6.76	1.17	20.99	2.54	0	0	389
Japan	33.07	2.31	11.15	1.5	10.99	1.45	12.02	1.33	1.74	0.52	3.31	0.79	2.13	0.76	13.29	1.65	6.38	1.12	5.02	1.15	0.91	0.4	485
Korea	15.7	1.81	7.16	1.05	17.15	1.47	15.07	1.59	15.82	1.62	11.42	1.35	0.51	0.26	9.2	1.09	5.92	1.08	2.04	0.67	0	0	615
Netherlands	4.44	1.03	7.95	1.6	3.55	0.93	28.3	2.23	2.78	0.83	2.65	0.78	2.99	0.85	26.62	1.82	4.23	0.84	13.94	1.9	2.53	0.73	433
Norway	7.01	1.44	11.77	1.43	8.37	1.28	19.98	1.95	5.68	1	9.03	1.76	1.98	0.72	24.81	1.77	4.49	1.18	6.89	1.24	0	0	430
Poland	9.32	1.37	11.23	1.67	9.85	1.34	23.07	1.71	8.9	1.16	10.54	1.34	2.3	0.59	4.1	0.79	16.12	1.59	3.25	0.87	1.31	0.46	1054
Slovak Republic	5.87	1.05	7.27	1.3	8.17	1.07	18.94	1.69	5.18	0.87	6.81	1.11	5.97	1.14	9.09	1.38	24.07	1.99	8.43	1.29	0.19	0.19	609
Spain	6.38	1.12	7.23	1.16	11.87	1.35	17.94	1.56	7.38	1.18	4.6	0.95	1.26	0.45	11.59	1.35	3.67	0.92	27.82	1.91	0.25	0.26	591
Sweden	11.05	1.66	9.06	1.2	11.04	1.44	20.67	2.18	3.8	0.89	8.34	1.25	2.66	0.82	19.18	1.87	4.22	1.08	9.87	1.47	0.11	0.1	396
United Kingdom	15.57	1.84	4.65	0.69	19.84	1.8	29.85	2.14	8.65	1.15	3.91	0.83	0.71	0.31	9	1.22	0.65	0.53	6.21	0.81	0.95	0.47	1084
United States	7.68	1.25	7.64	1.27	7.76	1.01	15.39	1.72	7.06	1.19	0.91	0.45	0.76	0.52	18.76	1.73	5.37	1.51	9.54	1.02	19.12	1.46	570

	Men																						
	General programmes		Teacher training and education science		Humanities, languages and arts		Social sciences, business and law		Science, mathematics and computing		Engineering, manufacturing and construction		Agriculture and veterinary		Health and welfare		Services		Missing - below upper secondary education		Missing		N
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	
Belgium	12.56	1.6	5.2	1.2	5.13	0.99	11.94	1.61	13.82	2.02	36.37	2.52	2.18	0.67	2.09	0.68	2.66	0.72	7.84	1.33	0.21	0.22	404
Canada	23.79	1.36	2.16	0.52	5.17	0.8	14.82	1.4	15.1	1.29	19.71	1.34	1.27	0.4	3.16	0.73	5.09	0.94	9.03	1.08	0.69	0.26	1994
Czech Republic	2.15	0.61	1.27	0.43	4.49	0.87	12.54	1.69	3.21	0.71	55.79	2.66	4.22	1.16	0.56	0.25	10.35	1.2	5.31	1.06	0.13	0.13	579
Denmark	9.48	1.42	3.36	0.97	4.37	0.97	13.81	1.71	14.18	1.65	24.79	2.43	4.04	1.01	3.72	1.03	11.94	1.68	10.31	1.62	0	0	433
Estonia	22.81	1.56	0.24	0.17	1.2	0.42	10.5	1.27	6.29	0.81	32.11	1.77	1.48	0.47	0.14	0.14	9.06	0.94	14.83	1.44	1.35	0.46	668
Finland	14.58	1.62	1.51	0.54	4.37	0.76	11.55	1.31	2.7	0.59	42.08	2.19	5.12	1.14	3.31	0.79	5.02	0.95	0	0	9.77	1.64	533
France	5.76	0.99	2.75	0.67	3.12	0.73	11.09	1.43	10.42	1.2	27.55	1.57	5.66	1.04	2.85	0.59	17.07	1.65	13.4	1.36	0.34	0.18	537
Germany	5.46	0.98	1.62	0.68	4.3	1.15	17.65	1.73	6.34	1.2	39.98	2.26	2.67	0.75	3.7	0.89	6.59	1.41	10.47	1.64	1.21	0.42	493
Ireland	1.86	0.52	2.45	0.57	3.86	0.77	11.92	1.67	12.91	1.67	19.67	1.91	1.64	0.67	2.43	0.68	5.06	0.99	15.15	0.84	23.05	1.5	620
Italy	7.37	1.77	0.16	0.15	6.53	1.58	10.49	1.72	15.14	2.11	16.59	2.2	2.86	0.96	3.3	0.99	6.18	1.57	31.36	3.01	0	0	361
Japan	30.4	2.28	2.59	0.77	5.01	1.18	13.75	1.57	3.93	1.06	29.08	2.47	3.73	0.92	3.24	0.88	2.98	0.8	5.29	1.18	0	0	433
Korea	21.75	1.61	2.01	0.67	4.85	0.76	9.56	1.27	13.94	1.44	36.41	2.41	0.79	0.4	3.33	0.91	5.05	0.82	2.32	0.6	0	0	618
Netherlands	6	1.31	2.08	0.68	1.85	0.89	27.2	2.59	10.64	1.68	18.8	2.03	2.87	0.84	5.52	1.38	3.89	1.04	19.76	2.1	1.38	0.66	368
Norway	8.3	1.32	3.28	0.73	6.33	1.2	14.85	1.61	8.43	1.18	35.82	2.56	1.79	0.63	7.05	1.13	4.09	0.95	10.08	1.52	0	0	441
Poland	8.49	1.25	2.81	0.82	5.05	0.83	13.81	1.61	8.19	1.17	39.58	2.39	2.49	0.72	2.29	0.72	9.88	1.37	6.35	1.21	1.06	0.55	999
Slovak Republic	3.97	0.77	2.8	0.84	4.02	0.99	8.32	1.37	10.33	1.47	43.02	1.97	5.41	1.13	1.2	0.54	12.33	1.52	8.28	0.93	0.33	0.24	591
Spain	5	1	3.27	0.87	5.82	1.04	11.28	1.42	8.06	1.26	20.94	1.74	1.31	0.45	3.24	0.9	2.73	0.79	38.18	2.07	0.16	0.16	554
Sweden	12.1	1.75	1.99	0.65	6.76	1.24	15.11	1.66	8.56	1.24	28.99	2.26	4.08	0.98	4.37	0.88	5.33	1.03	12.6	1.68	0.11	0.11	407
United Kingdom	14.98	1.74	3.73	0.97	13.77	1.8	21.01	2.12	12.7	1.72	25.17	2.23	0.29	0.19	2.07	0.62	0	0	5.81	1.11	0.48	0.32	718
United States	5.4	1.4	2.62	0.75	5.05	1.23	16.35	1.75	14.57	2.35	12.74	1.71	0.88	0.59	3.25	0.98	3.61	0.89	10.61	1.65	24.92	1.65	457

Source: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied.

Table A4.6 Fields of study in upper secondary and tertiary education, 55-64 year olds in PIAAC 2012

	Women																						
	General programmes		Teacher training and education science		Humanities, languages and arts		Social sciences, business and law		Science, mathematics and computing		Engineering, manufacturing and construction		Agriculture and veterinary		Health and welfare		Services		Missing - below upper secondary education		Missing		N
Country	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	
Belgium	15.34	1.63	10.29	1.41	4.41	0.9	9.23	1.24	4.43	0.99	5.18	1.08	0.18	0.18	11.43	1.45	3.2	1.03	36.32	2.05	0	0	513
Canada	25.46	1.22	9.19	0.82	6.6	0.73	15.23	1.19	3.91	0.55	1.15	0.36	0.22	0.11	13.96	0.97	5.14	0.6	17.88	1.06	1.24	0.32	3088
Czech Republic	5.93	1.4	6.05	0.86	2.19	0.5	23.07	2.15	1.91	0.78	21.95	2.09	2.65	0.64	4.5	1.09	10.69	1.29	21.01	1.48	0.04	0.04	788
Denmark	8.35	0.91	14.91	0.89	4.93	0.58	8.6	0.81	3.79	0.56	2.94	0.54	0.58	0.24	20.14	1.23	14.52	1.27	21.08	1.48	0.15	0.15	1135
Estonia	18.53	1.19	7.83	0.87	3.96	0.66	18.93	1.2	1.93	0.49	20.19	1.33	5.53	0.59	6.84	0.91	5.22	0.64	9.96	0.83	1.08	0.25	993
Finland	4.68	0.77	5.46	0.76	2.94	0.6	21.41	1.34	1.05	0.35	5.61	0.82	1.2	0.39	20.57	1.23	11.88	0.99	0	0	25.22	1.6	726
France	12.43	1.35	3.85	0.68	5.06	0.66	7.67	0.65	4.21	0.6	2.59	0.5	0.94	0.32	8.28	0.81	11.33	0.92	43.19	1.62	0.46	0.23	766
Germany	0.65	0.35	6.62	0.86	2.78	0.7	40.21	2.52	2.81	0.68	8.76	1.64	1.12	0.46	12.37	1.44	7.45	1.11	13.58	1.77	3.66	0.83	506
Ireland	6.95	1.1	5.64	0.77	4.46	0.81	5.43	0.81	2.45	0.61	0.08	0.09	0.47	0.25	6.57	0.91	2.22	0.69	48.5	1.41	17.23	1.54	614
Italy	2.49	0.63	3.28	0.63	8.21	1.41	4.52	1.09	4.54	0.91	0.4	0.25	0.05	0.05	1.57	0.46	1.86	0.6	73.09	2.31	0	0	541
Japan	43.89	1.88	9.89	1.34	5.2	0.73	7.11	1.07	1.23	0.51	0.65	0.26	0.84	0.36	4.03	0.67	6.37	1.07	20.15	1.42	0.63	0.33	635
Korea	21.72	1.78	3.27	0.6	3.4	0.77	3.13	0.77	0.79	0.37	0.88	0.34	0.74	0.39	0.97	0.27	0.57	0.29	64.53	1.86	0	0	632
Netherlands	8.59	1.26	8.24	1.14	5.04	1	8.96	1.31	0.88	0.39	0.63	0.37	0	0	15.09	1.5	1.04	0.46	48.99	1.91	2.54	0.68	577
Norway	10.4	1.75	8.62	1.26	6.65	1.13	21.41	2.3	4.41	1.03	6.87	1.16	0.83	0.42	21.54	2.06	2.28	0.66	16.79	1.86	0.19	0.19	410

Poland	10.17	1.48	4.61	0.92	5.46	1.09	8.85	1.06	6.41	1.01	20.33	1.89	10.18	1.44	5.27	0.93	12.25	1.5	15.49	1.68	0.98	0.43	544
Slovak Republic	10.11	1.4	5.25	1.01	3.79	0.84	15.19	1.72	3.12	0.67	8.77	1.2	5.49	1.04	7.24	1.27	17.69	1.46	23.37	1.71	0	0	642
Spain	6.16	1.32	4.02	0.86	5.56	1.22	7.54	1.29	2.68	0.73	0.78	0.42	0	0	4.88	0.9	2.01	0.71	66.18	1.88	0.21	0.19	521
Sweden	9.02	1.34	11.03	1.05	3.5	0.85	22.64	2.37	1.81	0.45	4.23	0.92	0.29	0.2	22.33	1.84	4.16	0.88	20.99	1.2	0	0	500
United Kingdom	18.12	1.71	8.02	1.1	16.38	1.8	16.52	1.69	5.75	1.05	1.95	0.77	0.45	0.32	9.57	1.37	0	0	21.95	1.42	1.28	0.74	1023
United States	6.3	0.83	10.84	1.32	6.28	1.06	11.29	1.27	7.2	1.24	1.29	0.46	0.3	0.24	12.69	1.08	3.76	0.72	9.83	0.76	30.22	1.59	589

	Men																						
	General programmes		**Teacher training and education science**		**Humanities, languages and arts**		**Social sciences, business and law**		**Science, mathematics and computing**		**Engineering, manufacturing and construction**		**Agriculture and veterinary**		**Health and welfare**		**Services**		**Missing - below upper secondary education**		**Missing**		**N**
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	
Belgium	9.21	1.27	3.92	0.79	2.97	0.62	7.37	1.36	8.36	1.22	34.66	2.24	2.14	0.68	2.53	0.7	1.22	0.42	27.62	1.97	0	0	511
Canada	21.64	1.3	3.59	0.55	4.39	0.53	12.01	1.09	8.78	0.95	21.94	1.35	0.97	0.23	1.7	0.34	5.23	0.63	18.4	1.12	1.35	0.35	2817
Czech Republic	2.85	0.65	1.81	0.65	0.75	0.36	6.71	1.25	1.16	0.5	69.35	2.83	3.96	0.72	0.06	0.04	4.6	1.03	6.42	1.41	2.33	1.2	602
Denmark	7.76	0.79	7.56	0.81	2.98	0.51	11.28	1.03	4.66	0.71	28.94	1.29	4.61	0.69	2.67	0.51	12.78	1.07	16.77	1.45	0	0	1133
Estonia	22.4	1.65	0.57	0.29	1.75	0.5	4.99	0.86	1.9	0.45	36.02	1.88	3.77	0.78	0.77	0.35	9.69	1.07	16.94	1.32	1.19	0.46	680
Finland	3.34	0.72	2.36	0.51	1.73	0.46	8.69	1.11	1.47	0.51	41.06	1.7	5.79	0.82	1.97	0.62	2.89	0.59	0	0	30.7	1.45	705
France	8.06	0.99	1.75	0.42	1.98	0.45	4.13	0.62	6.04	0.8	22.88	1.55	4.06	0.72	1.98	0.48	7.97	0.86	40.19	1.55	0.97	0.37	771

Germany	0.93	0.39	3.31	0.78	3.33	0.88	15.82	1.79	2.47	0.65	56	2.65	3.55	0.92	3.13	0.76	4.54	1.14	5.62	1.19	1.31	0.54	463
Ireland	2.3	0.65	0.83	0.36	2.84	0.67	4.2	0.75	4.68	0.82	10.78	1.34	1.61	0.59	1.42	0.54	1.42	0.51	50.18	1.67	19.72	1.74	500
Italy	3.79	1.08	0.56	0.29	2.85	0.71	4.01	0.98	7.22	1.29	8.82	1.38	0.67	0.32	3.38	0.83	2.01	0.74	66.7	3.53	0	0	448
Japan	23.66	1.76	4.28	0.77	1.91	0.47	17.38	1.66	2.41	0.65	28.02	1.94	5.29	0.92	0.92	0.4	0.77	0.41	15.25	1.25	0.12	0.13	617
Korea	21.85	1.61	2.05	0.67	4.2	0.88	8.26	1.23	2.28	0.62	13.04	1.54	4.97	0.8	1.03	0.44	1.26	0.57	41.06	2.07	0	0	549
Netherlands	5.13	0.89	4.41	0.79	4.23	0.89	13.25	1.45	4.89	0.85	22.72	1.97	2.61	0.67	2.96	0.81	2.04	0.64	35.02	2.12	2.73	0.78	645
Norway	4.67	1.08	4.6	0.91	5.23	1.02	13.07	1.29	5.92	1.08	37.48	2.23	3.71	0.87	4.37	0.93	3.09	0.83	17.58	1.95	0.28	0.28	476
Poland	4.55	0.84	1.46	0.57	1.06	0.48	3.1	0.98	2.6	0.72	57.75	2.62	5.32	1.37	0.4	0.29	6.33	1.16	17.01	1.71	0.42	0.26	450
Slovak Republic	2.89	0.92	1.58	0.57	1.59	0.6	5.03	1.13	4.36	0.99	55.63	2.39	10.03	1.33	0.87	0.45	7.59	1.39	10.29	1.4	0.14	0.15	502
Spain	7.4	1.31	1.88	0.64	3.14	0.82	6.4	1.19	5.17	1.1	13.57	1.51	1.46	0.67	1.25	0.55	0.49	0.28	58.87	2.01	0.37	0.26	484
Sweden	4.48	1.01	4.71	0.72	2.07	0.63	15.09	1.72	2.54	0.59	34.97	2	2.62	0.6	4.99	0.76	2.47	0.72	25.74	1.09	0.32	0.32	532
United Kingdom	15.23	2.3	2.74	0.74	9.65	1.48	7.88	1.04	10.3	1.59	31.36	2.2	1.6	0.63	2.1	0.82	0	0	19.13	1.57	0.01	0.01	782
United States	6.39	1.35	5.36	1.21	4.99	1.01	14.58	1.87	9.21	1.31	10.88	1.56	1.83	0.51	4.85	1.18	3.69	0.92	10.98	1.12	27.24	1.82	455

Source: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied.

Table A4.7 OLS regression predicting average gender difference in numeracy by country: 25-34 year olds

	Belgium						Canada						Czech Republic						Denmark					
	M2		M3		M4		M2		M3		M4		M2		M3		M4		M2		M3		M4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Gender (m)	9.91	3.35	16.91	3.14	16.14	3.21	12.81	2.63	16.63	2.59	13.75	2.80	5.58	3.98	12.79	3.60	12.17	4.54	16.85	3.25	20.58	3.16	19.67	3.27
Immigrant status	-48.76	6.32	-35.04	6.00	-35.54	5.80	-17.76	3.08	-22.84	2.88	-23.29	2.94	0.04	7.90	0.41	6.10	-0.87	6.28	-37.35	4.52	-33.78	4.04	-34.69	3.95
Parental education	22.97	3.06	8.38	3.04	7.22	3.01	23.03	2.66	11.71	2.64	11.22	2.64	28.69	4.73	8.02	4.70	8.11	4.69	21.70	3.38	13.05	3.20	12.63	3.20
Upper secondary			30.34	5.90	30.20	6.12			38.36	5.55	-8.83	33.47			20.43	6.81	10.38	10.62			24.08	6.35	13.86	8.56
Post-secondary, non-tertiary			34.79	8.83	33.75	8.93			45.83	6.20	-4.24	33.22			24.78	10.17	14.89	13.45			34.45	11.36	23.86	12.28
Tertiary			66.54	6.19	63.38	6.30			71.81	5.81	21.48	33.30			62.30	7.89	51.64	10.91			48.24	6.14	36.69	8.16
Field of study: science					19.01	5.11					15.74	4.53					12.46	7.70					22.75	5.77
Field of study: engineering					-1.85	3.86					9.53	4.39					0.52	5.32					-2.67	4.80
Field of study: missing											-47.53	33.44					-12.02	14.12					-13.57	10.40
Rsquared	0.20		0.38		0.40		0.09		0.24		0.25		0.07		0.25		0.26		0.17		0.28		0.31	
Intercept	287.80		242.59		243.28		264.62		214.49		262.81		280.43		248.91		258.99		281.05		249.12		258.65	
N	853		853		853		4574		4574		4574		1333		1333		1333		930		930		930	

	Estonia						Finland						France						Germany					
	M2		M3		M4		M2		M3		M4		M2		M3		M4		M2		M3		M4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Gender (m)	9.16	3.06	15.97	2.92	17.85	3.02	6.42	3.01	12.69	2.94	12.48	3.32	8.86	2.71	13.85	2.31	12.90	2.34	7.19	3.24	8.90	3.31	12.11	3.61
Immigrant status	-7.24	3.73	-5.93	3.62	-6.28	3.62	-84.92	10.75	-76.01	10.83	-76.38	10.76	-35.56	3.59	-25.30	2.92	-25.11	2.96	-31.49	4.39	-30.20	4.10	-22.79	3.72
Parental education	24.26	2.96	15.08	2.76	14.13	2.81	23.51	4.02	15.78	3.94	15.56	3.95	38.13	3.28	16.25	2.97	16.39	2.91	27.42	3.73	17.11	3.67	13.39	3.43

Upper secondary			28.76	3.91	9.03	9.77			19.84	6.54	19.58	6.62	8.21		33.72	4.23	54.92	15.67			7.88	5.24	-29.25	5.23
Post-secondary, non-tertiary			38.97	5.76	19.55	11.11															-22.46	5.56	-22.04	5.59
Tertiary			53.22	3.73	30.62	9.53			50.53	6.59	49.39	6.75			73.75	3.95	93.00	15.80			46.11	4.99	9.32	4.67
Field of study: science					17.04	5.52					12.36	10.77					17.70	3.59					2.46	6.05
Field of study: engineering					-12.10	3.63					0.59	3.90					2.04	3.82					-6.77	4.42
Field of study: missing					-25.43	10.06											23.00	16.97					-76.50	7.61
Rsquared	0.09		0.24		0.26		0.20		0.31		0.31		0.19		0.41		0.42		0.17		0.28		0.40	
Intercept	269.86		234.14		256.73		296.67		264.82		265.05		266.35		220.96		198.85		273.97		259.76		296.76	
N	1406		1406		1406		1044		1044		1044		1143		1143		1143		979		979		979	

	Ireland						**Italy**						**Japan**						**Korea**					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	11.44	3.37	15.43	3.21	13.30	3.07	11.34	4.37	16.20	4.00	14.11	4.19	9.79	3.01	10.74	2.84	7.37	3.18	4.93	2.23	7.64	2.27	7.94	2.52
Immigrant status	-14.93	3.87	-14.89	3.67	-14.87	3.63	-23.77	7.88	-16.60	7.75	-17.42	7.92	-94.63	14.47	-68.22	15.70	-63.98	17.42	-32.04	10.14	-19.84	10.46	-20.27	10.51
Parental education	24.57	3.54	12.02	3.37	12.57	3.33	25.61	6.69	7.73	6.25	7.04	6.14	15.21	3.12	7.36	3.45	7.71	3.47	18.28	2.94	13.04	2.98	12.84	3.08
Upper secondary	6.56		33.59	5.49	33.46	5.49	6.06		30.23	5.28	2.60	12.74	3.36		20.15	6.08	17.12	8.06	7.744***		30.24	10.64	30.79	10.74
Post-secondary, non-tertiary			32.16	5.62	27.98	6.00			61.89	18.13	37.65	21.78			21.03	11.76	15.62	12.72						
Tertiary			63.57	5.57	59.99	5.73			51.44	5.26	24.73	12.80			41.35	6.14	37.04	8.32			51.38	10.23	52.17	10.42
Field of study: science					14.37	4.19					12.06	6.10					18.77	8.17					-2.65	3.52
Field of study: engineering					6.83	5.94					12.10	7.60					11.14	3.69					-1.29	2.96
Field of study: missing											-24.50	13.10					-3.78	11.05						
Rsquared	0.07		0.24		0.25		0.06		0.20		0.22		0.07		0.16		0.18		0.06		0.15		0.15	
Intercept	257.38		216.19		217.33		257.94		229.04		253.36		285.51		258.14		261.07		275.64		232.33		232.24	
N	1393		1393		1393		750		750		750		918		918		918		1233		1233		1233	

	Netherlands						**Norway**						**Poland**						**Slovak Republic**					

	M2		M3		M4		M2		M3		M4		M2		M3		M4		M2		M3		M4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Gender (m)	10.75	3.53	15.00	3.04	12.01	3.20	12.14	3.03	18.76	2.87	16.71	2.88	4.93	3.10	9.98	3.09	8.59	3.33	0.95	2.99	4.18	2.75	2.55	2.76
Immigrant status	-43.02	5.88	-34.57	5.27	-34.86	5.18	-43.01	5.50	-41.60	4.95	-40.37	4.94	-19.53	15.26	-28.74	15.23	-26.83	15.14	-18.45	14.80	-12.91	17.19	-13.10	16.47
Parental education	22.63	3.81	12.03	3.62	11.17	3.60	21.77	3.35	9.61	2.74	9.03	2.73	31.82	4.06	18.03	4.10	18.31	4.05	32.49	4.13	13.11	4.07	12.71	3.99
Upper secondary			33.16	5.64	30.34	5.85			25.90	5.68	13.05	6.48			23.35	7.45	21.36	7.60			61.55	4.93	33.70	7.68
Post-secondary, non-tertiary									33.48	8.20	20.72	8.85			32.30	8.80	29.95	8.99			71.24	12.98	44.74	14.09
Tertiary			60.85	5.48	58.00	5.59			57.47	5.53	45.88	5.99			55.75	8.20	54.05	8.28			87.45	5.33	58.22	7.66
Field of study: science					19.24	6.90					10.59	6.90					3.93	5.36					19.00	5.28
Field of study: engineering					7.98	4.98					6.59	3.79					4.68	3.72					1.17	3.82

Table A4.5 continued

Field of study: missing											-21.57	8.64											-36.68	9.37
Rsquared	0.20		0.38		0.39		0.19		0.35		0.37		0.08		0.20		0.20		0.06		0.30		0.32	
Intercept	287.80		248.85		250.87		282.71		248.39		259.26		264.42		226.62		227.52		273.11		212.76		239.94	
N	789		789		789		871		871		871		2053		2053		2053		1200		1200		1200	

	Spain						Sweden						UK						USA					
	M2		M3		M4		M2		M3		M4		M2		M3		M4		M2		M3		M4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Gender (m)	8.42	2.80	14.11	2.75	12.41	2.85	12.17	3.48	17.58	3.35	16.60	3.69	14.03	3.80	13.18	3.45	12.03	3.61	13.59	3.49	19.41	2.86	16.78	3.05
Immigrant status	-27.67	3.51	-21.81	3.68	-21.40	3.72	-64.60	5.43	-60.32	5.18	-60.43	5.16	-38.00	5.03	-43.68	5.01	-43.57	4.95	-19.30	5.44	-15.73	4.20	-16.50	4.32
Parental education	30.70	3.36	15.56	3.48	15.30	3.53	22.25	3.90	9.54	3.54	9.68	3.61	40.16	3.71	24.46	3.84	23.50	3.85	38.78	4.06	19.79	3.78	19.37	3.75
Upper secondary			28.52	3.50	19.89	8.91			29.39	6.09	32.23	14.47			42.66	4.45	33.59	4.55			37.03	7.09	34.82	7.13
Post-secondary, non-tertiary			32.39	9.13	20.58	11.77			41.82	8.07	44.32	15.89			17.19	25.58	9.69	25.96			54.52	7.41	50.27	7.81
Tertiary			44.89	3.03	37.00	8.70			62.93	6.29	65.16	14.47			65.54	5.00	56.19	5.05			87.01	7.57	81.40	7.91

Field of study: science					19.23	3.99					7.14	7.78					15.74	5.37					24.85	5.46
Field of study: engineering					7.33	4.17					2.40	4.96					3.66	7.10					4.81	8.18
Field of study: missing					-4.68	8.45					4.36	15.49					-24.38	9.71						
Rsquared	0.13		0.29		0.30		0.26		0.38		0.38		0.19		0.34		0.36		0.16		0.38		0.40	
Intercept	254.09		227.32		232.74		285.25		247.90		244.78		258.82		218.80		226.52		239.84		188.31		190.70	
N	1145		1145		1145		803		803		803		1802		1802		1802		1027		1027		1027	

Source: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

Table A4.8 OLS regression predicting average gender difference in numeracy by country: 55-64 year olds

	Belgium						**Canada**						**Czech Republic**						**Denmark**					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	19.42	3.59	16.83	3.36	17.41	3.46	19.59	2.59	18.94	2.48	17.01	2.61	2.80	4.35	-4.51	4.00	-4.20	4.90	13.61	2.14	12.88	2.03	13.11	2.19
Immigrant status	-23.61	7.11	-25.32	6.94	-25.46	7.03	-17.22	3.53	-21.48	3.27	-21.47	3.27	-10.02	15.25	-6.94	10.20	-7.36	10.54	-18.73	4.24	-19.95	3.86	-19.84	3.85
Parental education	29.15	4.22	6.96	4.67	6.88	4.69	30.64	3.27	16.03	3.09	15.80	3.04	25.30	7.85	9.25	7.21	8.72	7.32	25.71	3.30	11.09	3.32	10.82	3.26
Upper secondary			26.05	4.05	27.27	4.49			40.00	3.79	11.66	48.48			27.59	5.09	19.82	10.33			20.38	2.86	13.41	4.32
Post-secondary, non-tertiary			33.30	10.64	33.13	10.79			46.92	4.40	16.64	48.41			72.91	26.71	64.84	28.60			24.42	7.32	17.05	7.83
Tertiary			55.00	3.83	52.49	4.04			67.83	3.24	37.02	48.36			62.95	6.75	54.80	11.01			47.93	2.93	39.65	4.52

Field of study: science					16.76	6.68											22.52	9.87					24.11	4.84
Field of study: engineering					-4.49	4.64											-0.50	4.88					-1.08	3.14
Field of study: missing																	-10.48	12.44					-9.00	4.97
Rsquared	0.08		0.25		0.26		0.09		0.27		0.28		0.03		0.22		0.23		0.07		0.22		0.23	
Intercept	249.09		226.98		226.74		241.16		199.65		228.37		261.13		236.71		244.29		258.42		236.65		243.04	
N	1024		1024		1024		5905		5905		5905		1390		1390		1390		2268		2268		2268	
	Estonia						**Finland**						**France**						**Germany**					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	-0.71	2.27	4.37	2.26	2.85	2.37	10.17	3.14	11.74	3.01	8.69	3.47	12.74	2.82	11.87	2.76	10.63	2.91	26.09	3.93	17.51	3.75	20.32	4.42
Immigrant status	-12.00	2.27	-14.42	2.22	-15.05	2.23	-34.07	15.81	-39.68	14.72	-41.05	14.80	-27.55	3.97	-25.88	3.68	-25.43	3.73	-13.36	5.42	-10.83	5.52	-10.57	5.43
Parental education	16.65	3.05	6.28	3.20	6.28	3.22	29.59	5.84	12.39	5.01	12.20	5.08	41.14	4.07	13.31	4.25	14.21	4.13	24.97	4.27	13.79	4.49	11.44	4.59
Upper secondary			23.26	3.46	9.41	7.12			21.97	4.06	19.02	4.24			29.70	2.70	27.25	11.59			27.19	7.56	-15.79	12.12
Post-secondary, non-tertiary			32.45	5.18	16.94	8.21															-17.67	5.18	-15.95	5.60
Tertiary			46.06	3.49	30.34	7.18			59.71	4.72	56.03	4.75			67.22	3.06	63.14	11.46			66.42	7.91	21.94	12.13
Field of study: science					23.25	7.85					24.67	9.75					27.17	4.91					6.40	8.47
Field of study: engineering					6.56	2.54					7.87	3.37					3.90	3.87					-7.47	4.85
Field of study: missing					-15.40	7.26											0.29	11.48					-58.01	14.08
Rsquared	0.03		0.16		0.17		0.04		0.19		0.19		0.07		0.26		0.27		0.12		0.26		0.29	
Intercept	262.86		234.39		247.52		254.40		233.23		234.89		232.86		210.92		211.11		241.19		212.68		257.57	

N	1673		1673		1673		1431		1431		1431		1537		1537		1537		942		942		942	
	Ireland						**Italy**						**Japan**						**Korea**					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	14.01	4.33	15.55	4.03	14.05	4.27	12.45	3.97	9.09	3.68	7.95	3.82	14.01	3.32	9.34	3.14	5.41	3.24	21.43	3.16	9.81	2.83	9.78	2.80
Immigrant status	11.05	7.36	0.45	6.31	0.03	6.25	2.11	12.08	1.71	13.38	3.54	13.35	5.04	46.36	-1.15	48.19	1.26	44.95	-10.68	19.17	-6.56	16.99	-6.56	16.99
Parental education	40.88	6.17	16.10	6.08	16.07	6.08	36.70	8.51	9.51	9.66	11.37	9.78	24.89	3.50	7.51	3.54	6.72	3.54	39.41	5.85	12.95	5.38	12.99	5.38
Upper secondary			32.18	4.98	32.26	4.99			36.99	3.94	-5.11	13.46			33.51	3.53	9.81	8.40			32.70	3.07	32.64	3.17
Post-secondary, non-tertiary			30.25	4.84	26.46	4.91			51.38	34.20	12.72	40.29			26.16	8.77	-0.14	10.92						
Tertiary			56.42	4.76	53.67	4.82			39.55	6.28	-0.31	14.43			58.02	4.54	33.96	8.72			59.04	4.01	58.90	4.10
Field of study: science					12.03	6.59					20.16	6.37					16.65	8.55					1.33	11.94
Field of study: engineering					10.26	8.35					20.95	7.72					12.51	4.82					0.35	6.00
Field of study: missing											-35.37	13.57					-27.16	8.96						
Rsquared	0.07		0.22		0.22		0.03		0.14		0.16		0.06		0.24		0.26		0.09		0.30		0.30	
Intercept	226.87		208.29		209.10		222.73		214.52		248.98		262.54		234.15		257.65		220.60		208.44		208.44	
N	1108		1108		1108		989		989		989		1252		1252		1252		1181		1181		1181	

	Netherlands						Norway						Poland						Slovak Republic					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	18.94	3.16	13.20	2.78	9.91	3.04	16.98	3.57	15.58	3.21	16.14	3.58	3.23	3.59	4.48	3.57	0.62	3.75	-2.55	2.90	-6.42	2.75	-7.15	3.09
Immigrant status	-43.07	7.75	-42.67	6.87	-42.60	6.83	-26.78	9.31	-34.90	8.89	-35.77	8.77	-0.28	9.28	-1.35	9.13	-0.76	8.85	5.37	8.24	-0.46	6.39	0.40	6.21
Parental education	29.46	4.54	7.54	4.38	7.72	4.32	19.35	5.27	2.93	5.05	2.64	4.95	21.14	7.42	4.64	8.02	4.98	7.86	24.11	6.57	4.82	7.67	3.73	7.25
Upper secondary			25.98	3.66	22.48	3.75			14.13	4.90	0.50	6.37			26.93	4.54	20.95	4.97			39.96	4.27	26.63	5.24
Post-secondary, non-tertiary									14.40	5.19	1.78	6.48			38.64	6.77	32.42	7.53			61.66	27.05	48.25	26.97
Tertiary			49.68	3.45	46.58	3.46			46.65	4.63	33.27	5.87			56.74	6.62	52.31	6.62			65.21	4.83	50.80	6.21
Field of study: science					20.58	8.15					25.67	7.38					10.97	6.93					13.50	8.07
Field of study: engineering					12.77	4.56					0.85	4.35					11.10	4.03					-2.18	3.95
Field of study: missing											-23.54	6.69											-20.86	5.98
Rsquared	0.14		0.29		0.30		0.07		0.22		0.26		0.01		0.13		0.14		0.01		0.22		0.24	
Intercept	253.97		237.89		239.24		257.05		239.71		251.20		247.19		219.70		221.54		265.09		235.21		249.24	
N	1197		1197		1197		886		886		886		994		994		994		1144		1144		1144	

	Spain						Sweden						UK						USA					
	M2		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**		**M2**		**M3**		**M4**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Gender (m)	17.37	3.18	14.00	2.84	13.65	3.02	16.77	3.02	16.82	2.94	15.49	3.33	19.37	3.48	16.62	3.60	15.01	3.72	18.61	4.01	17.11	3.72	14.65	3.59
Immigrant status	-20.21	11.08	-22.95	10.06	-22.46	10.15	-38.53	5.66	-36.94	5.45	-37.36	5.40	-27.52	7.72	-28.03	7.04	-27.03	6.73	-45.18	8.03	-27.85	8.61	-28.17	8.53

Parental education	42.96	6.46	11.74	6.23	10.78	6.21	19.86	4.11	6.22	3.82	6.32	3.81	29.39	7.10	14.62	6.35	13.71	5.94	31.24	4.24	15.17	4.04	15.55	4.09
Upper secondary			37.28	4.32	72.35	24.13			22.78	3.79	20.06	5.69			25.76	4.19	3.21	4.87			53.65	7.45	51.51	7.47
Post-secondary, non-tertiary			54.81	14.71	91.96	31.38			52.77	5.50	49.21	6.76			30.81	52.45	9.90	51.47			56.79	8.42	49.56	9.08
Tertiary			54.80	4.09	91.51	24.47			51.42	4.76	49.39	6.18			49.61	4.71	26.64	5.28			88.90	7.99	84.20	8.10
Field of study: science					15.33	7.34					9.43	11.24					25.63	5.91					23.29	6.65
Field of study: engineering					0.06	6.51					4.74	4.14					3.65	5.45					21.08	7.33
Field of study: missing					37.43	24.02					-1.61	6.40					-34.58	5.49						
Rsquared	0.08		0.27		0.27		0.13		0.30		0.30		0.08		0.22		0.28		0.15		0.34		0.36	
Intercept	213.26		199.67		162.43		262.28		238.49		240.21		248.58		227.31		247.34		236.32		177.00		178.32	
N	1005		1005		1005		1032		1032		1032		1805		1805		1805		1044		1044		1044	

Source: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Results averaged across ten plausible values.

APPENDIX TO CHAPTER 5

Table A5.1 Work status by gender

	Employed		Unemployed		Retired		Student		Unpaid household work		Other		Missing		N
	Women														
Country	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	
Czech Republic	56.03	0.74	5.3	0.51	12.67	0.5	11.5	0.29	10.13	0.34	4.37	0.44	0	0	3,316
Denmark	58.62	0.76	6.37	0.48	11.81	0.4	17.89	0.55	1.81	0.25	3.5	0.4	0	0	3,492
France	57.99	0.59	9.63	0.44	8.24	0.36	11.54	0.47	9.36	0.5	3.21	0.3	0.04	0.04	3,266
Germany	58.45	1.09	4.47	0.45	5.89	0.48	12.97	0.45	10.89	0.74	5.58	0.45	1.76	0.27	2,789
Ireland	53.3	1.04	8.27	0.58	3	0.28	11.68	0.69	18.69	0.83	4.99	0.47	0.01	0.01	3,239
Italy	41.33	0.92	12.75	0.94	7.76	0.65	10.52	0.77	23.46	1.18	4.05	0.5	0.13	0.09	2,294
Japan	58.31	0.68	4.39	0.47	0.82	0.23	6.8	0.31	28.11	0.8	1.54	0.28	0.03	0.03	2,704
Korea	51.54	0.99	2.47	0.29	0.31	0.11	12.91	0.6	29.29	0.81	3.41	0.31	0.06	0.04	3,471
Netherlands	59.92	0.98	2.96	0.37	3.17	0.32	12.16	0.42	13.25	0.65	6.42	0.49	0	0	2,625
Norway	67.2	0.91	2.9	0.34	1.95	0.32	15.46	0.5	3.12	0.4	9.37	0.63	0	0	2,294
Poland	49.07	0.75	8.85	0.53	12.42	0.5	11.93	0.21	12.38	0.63	5.29	0.45	0.04	0.04	4,523
Slovak Republic	51.11	0.92	10.94	0.62	13.22	0.42	11.82	0.38	1.65	0.27	11.26	0.59	0	0	2,971
Spain	49.21	0.99	17.1	0.76	3.33	0.4	9.04	0.43	18.17	0.73	3.14	0.34	0	0	2,942
Sweden	64.79	0.91	5.24	0.55	8.89	0.53	14.08	0.57	4.12	0.45	2.77	0.41	0.12	0.1	2,216
USA	59.68	1.05	8.48	0.65	3.98	0.38	9.56	0.61	10.55	0.64	7.72	0.64	0.02	0.02	2,637
UK	62.55	0.44	6.37	0.42	7.3	0.34	7.8	0.45	11.73	0.54	4.2	0.37	0.04	0.04	4,994
	Men														
Czech Republic	70.81	0.69	4.67	0.5	8.53	0.48	10.64	0.3	0.24	0.1	5.08	0.44	0.04	0.04	2,744

Denmark	66.84	0.76	6.65	0.48	9.28	0.47	14.89	0.58	0.1	0.04	2.23	0.32	0.01	0.01	3,347
France	65.05	0.51	10.39	0.52	10.15	0.39	10.77	0.4	0.27	0.09	3.36	0.27	0	0	3,160
Germany	71.01	0.74	5.83	0.5	4.64	0.41	12.88	0.42	0.38	0.15	4.06	0.42	1.2	0.24	2,676
Ireland	59.82	1.03	15.94	0.78	2.94	0.28	13.23	0.67	1.23	0.21	5.98	0.57	0.16	0.09	2,744
Italy	63.69	1.03	12.9	0.87	9.21	0.66	10.87	0.87	0.08	0.04	3.25	0.5	0	0	2,130
Japan	80.74	0.69	5.76	0.47	3	0.37	8.48	0.34	0.34	0.15	1.66	0.28	0.02	0.02	2,465
Korea	76.31	0.84	4.58	0.42	1.47	0.23	12.8	0.64	0.45	0.13	4.39	0.44	0	0	3,002
Netherlands	71.34	0.9	5.41	0.5	5.19	0.29	10.98	0.5	0.28	0.1	4.52	0.39	0.11	0.07	2,545
Norway	73.87	0.68	2.96	0.35	2.08	0.27	13.27	0.43	0.16	0.08	7.65	0.56	0	0	2,453
Poland	63.45	0.85	10.36	0.66	6.46	0.42	11.57	0.23	0.83	0.2	7.29	0.55	0.04	0.04	4,550
Slovak Republic	65.42	0.82	12.5	0.58	7.51	0.5	10.48	0.44	0.98	0.21	3.11	0.39	0	0	2,659
Spain	59.45	0.91	21.27	0.8	5.94	0.39	8.47	0.42	0.55	0.14	4.28	0.44	0.03	0.03	2,848
Sweden	71.77	0.85	6.84	0.55	5.76	0.51	13.34	0.52	0.4	0.14	1.85	0.29	0.04	0.04	2,253
USA	68.91	0.98	8.3	0.49	3.06	0.32	10.74	0.7	0.61	0.16	8.27	0.82	0.08	0.07	2,261
UK	71.66	0.56	8.29	0.38	5.18	0.33	8.93	0.67	0.81	0.16	5.13	0.46	0	0	3,587

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Missing category combines 'don't know' and 'valid skip' responses.

Table A5.2 Total sample, exclusions and analytic sample for each country

	All	Employed only	Employed - male	Employed - female	Employed with non-missing occupation	% of full sample included	% of employed sample included
Czech Republic	6,060	3,213	1,684	1,529	3,177	52.43	98.88
Denmark	6,839	4,408	2,285	2,123	4,388	64.16	99.55
France	6,426	4,048	2,093	1,955	3,989	62.08	98.54
Germany	5,479	3,483	1,848	1,635	3,456	63.08	99.22
Ireland	5,983	3,446	1,689	1,757	3,393	56.71	98.46
Italy	4,424	2,599	1,459	1,140	2,578	58.27	99.19
Japan	5,169	3,675	1,989	1,686	3,638	70.38	98.99
Korea	6,473	4,069	2,276	1,793	4,035	62.34	99.16
Netherlands	5,170	3,466	1,816	1,650	3,452	66.77	99.60
Norway	4,747	3,380	1,816	1,564	2,934	61.81	86.80
Poland	9,073	4,274	2,464	1,810	4,229	46.61	98.95
Slovak Republic	5,630	3,113	1,669	1,444	3,081	54.72	98.97
Spain	5,790	3,082	1,671	1,411	3,026	52.26	98.18
Sweden	4,469	3,112	1,648	1,464	3,079	68.90	98.94
United States	4,898	3,134	1,534	1,600	3,089	63.07	98.56
UK	8,581	5,478	2,428	3,050	5,374	62.63	98.10

Source: Author's calculation using the PIAAC dataset.

Table A5.3 Distribution of occupation numeracy-intensiveness score by country: kernel density estimates

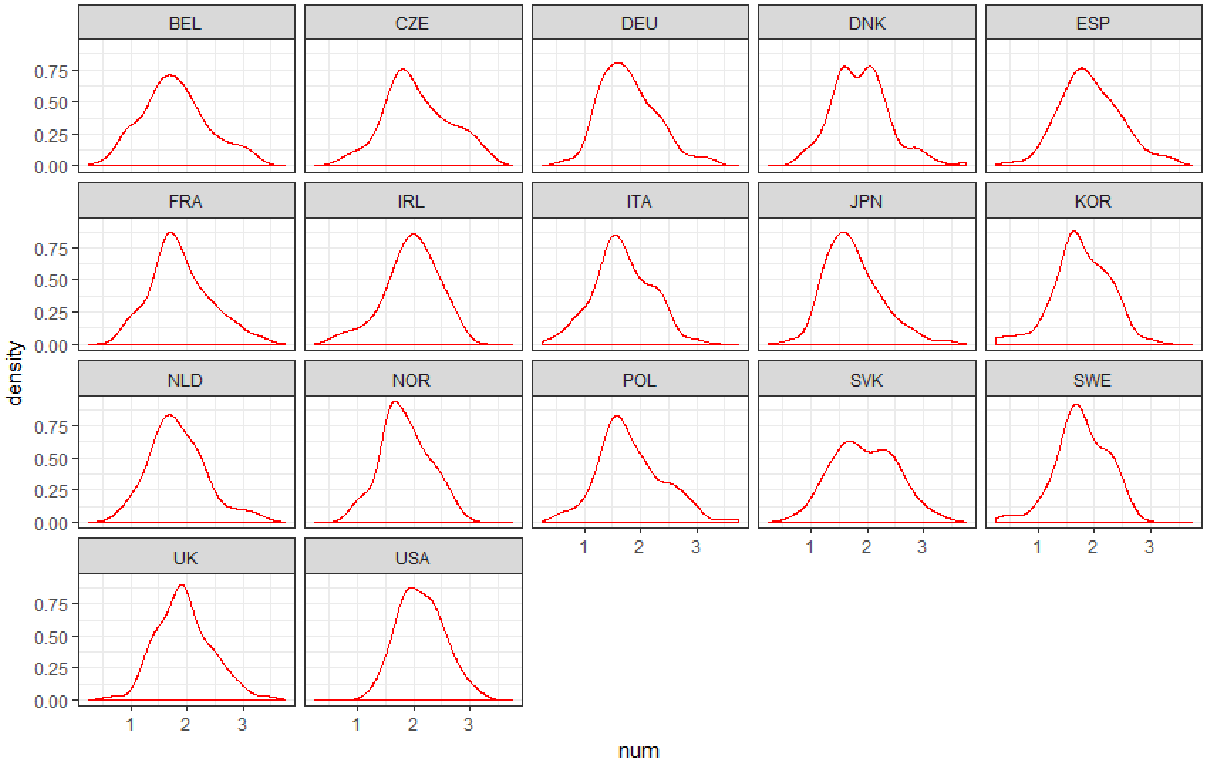


Table A5.4 Average occupational skills use scores by country and gender

Country	Gender	Numeracy	ICT	Reading	Writing	Planning	Learning	Task
Belgium	Men	1.86	1.79	2.00	2.00	2.00	1.88	2.18
	Women	1.7	1.72	1.96	1.99	1.85	1.85	2.13
Czech Republic	Men	2.1	1.65	1.89	1.69	2.05	1.83	2.14
	Women	2.1	1.83	1.95	1.76	2.07	1.82	2.15
Denmark	Men	1.98	1.88	2.16	1.89	1.99	1.92	2.29
	Women	1.8	1.85	2.16	1.99	1.92	1.97	2.25
France	Men	1.91	1.59	1.91	1.78	1.91	2.03	1.69
	Women	1.77	1.56	1.88	1.71	1.85	2	1.73
Germany	Men	1.98	1.76	2.11	1.98	1.35	1.77	2.04
	Women	1.87	1.68	2.13	1.98	1.28	1.8	2.02
Ireland	Men	1.99	1.7	2.05	1.95	2.16	1.9	1.65
	Women	1.92	1.71	2.05	2.05	2.22	1.95	1.54
Italy	Men	1.79	1.78	1.66	1.54	1.89	1.86	1.65
	Women	1.73	1.78	1.7	1.54	1.83	1.83	1.63
Japan	Men	1.87	1.52	2.18	2.19	1.44	1.82	2.32
	Women	1.58	1.31	2.01	2.08	1.36	1.82	2.18
Korea	Men	1.92	1.72	2.1	2.16	1.61	1.5	1.77
	Women	1.77	1.51	2.00	2.02	1.6	1.47	1.67
Netherlands	Men	1.98	1.97	2.16	2.01	2.03	1.92	1.98
	Women	1.69	1.81	2.11	2.08	1.92	1.83	1.87
Norway	Men	1.91	1.88	2.39	2.11	1.84	2.09	2.2
	Women	1.72	1.75	2.32	2.15	1.77	2.1	2.05
Poland	Men	1.8	1.52	1.72	1.67	1.97	1.81	1.86
	Women	1.9	1.66	1.98	1.86	1.95	1.83	1.92
Slovak Republic	Men	1.95	1.69	1.73	1.71	1.87	2.01	1.61
	Women	2.06	1.7	1.85	1.83	1.84	2.04	1.6
Spain	Men	1.92	1.67	1.87	1.88	1.96	2.34	1.79
	Women	1.86	1.66	1.9	1.85	1.91	2.2	1.78
Sweden	Men	1.87	1.66	2.22	1.84	1.9	2	2.26
	Women	1.74	1.62	2.25	1.84	1.91	2.01	2.18
USA	Men	2.23	1.77	2.19	2.04	2.01	2.16	1.83
	Women	2.15	1.83	2.22	2.13	1.97	2.14	1.82
UK	Men	2	1.84	2.08	1.96	2.14	1.92	1.77
	Women	1.88	1.79	2.08	2.04	2.21	2	1.71

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. All skills measured at median occupation level. 'Planning' = Index of Use of Planning Skills at Work. 'Learning' = Index of Learning at Work. 'Task' = Index of Use of Task Discretion at work.

Table A5.5 List of occupations and their features by country

Darkest shading = highest numeracy intensiveness quartile (quartile 4), lightest shading = lowest numeracy intensiveness quartile (quartile 1). 'Pccog' = score on principal component of cognitive skills use measures (numeracy, ICT, reading, writing). 'Pcf' = proportion women in occupation.

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occupation	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Managing directors and chief executives	112	2.64	2.92	2.71	1.96	2.87	3.02	3.73	2.44	2.20	6.90	4	29
Business services and administration managers	121	2.50	2.62	2.75	1.95	2.63	2.84	3.01	2.51	1.68	32.43	4	74
Sales, marketing and development managers	122	2.37	2.93	2.60	2.13	2.70	2.66	2.41	2.71	2.02	31.37	4	51
Manufacturing, mining, construction, and distribution managers	132	2.93	2.31	2.69	1.85	2.33	2.70	3.01	2.54	1.51	8.82	4	34
Information and communications technology service managers	133	3.17	2.72	3.06	1.79	2.72	2.43	1.96	2.92	2.70	26.67	4	15
Professional services managers	134	2.04	2.30	2.50	2.23	2.62	2.66	3.01	2.63	1.17	54.29	3	35
Hotel and restaurant managers	141	2.05	1.57	2.59	1.75	2.44	2.19	2.41	1.72	-0.22	47.37	3	19
Retail and wholesale trade managers	142	2.54	2.33	3.73	1.85	2.55	2.40	3.01	2.23	1.20	29.27	4	41
Other services managers	143	2.45	2.95	3.13	1.81	2.52	2.64	3.73	2.25	1.54	21.43	4	14
Engineering professionals (excluding electrotechnology)	214	3.02	2.49	2.40	2.26	2.26	2.41	3.01	2.53	1.62	9.68	4	31
Architects, planners, surveyors and designers	216	2.28	2.16	2.40	2.08	2.40	2.12	1.75	2.21	0.70	48.00	4	25
Medical doctors	221	1.52	2.14	2.32	1.74	2.96	2.54	1.96	3.49	1.68	31.58	2	19
Nursing and midwifery professionals	222	1.50	1.24	1.74	1.85	2.02	2.07	1.75	2.58	-0.69	89.13	2	92
Other health professionals	226	1.81	1.64	2.26	2.21	2.35	2.32	1.75	2.50	0.14	77.50	3	40
University and higher education teachers	231	2.38	2.18	2.21	1.74	3.04	2.82	1.75	2.36	1.60	46.67	4	15
Secondary education teachers	233	1.72	1.71	1.87	2.04	2.48	2.48	1.75	2.13	-0.03	61.18	2	85
Primary school and early childhood teachers	234	1.49	1.55	1.95	2.13	2.33	2.18	1.96	2.19	-0.44	85.29	2	68
Other teaching professionals	235	1.69	2.10	2.21	1.90	2.47	2.43	1.96	2.25	0.29	60.61	2	66
Finance professionals	241	3.13	2.62	2.43	2.05	2.72	2.27	1.75	2.38	2.18	41.54	4	65
Administration professionals	242	2.13	2.62	2.60	1.99	2.78	2.37	2.41	2.44	1.49	55.56	3	18
Sales, marketing and public relations professionals	243	3.02	2.82	3.22	1.90	2.95	2.55	1.75	2.73	2.75	36.36	4	11
Software and applications developers and analysts	251	2.15	2.36	2.14	2.05	2.34	1.92	1.75	2.05	0.53	17.07	4	41
Database and network professionals	252	2.15	2.68	2.22	2.17	2.98	1.86	1.75	2.32	1.66	25.00	3	12

Legal professionals	261	1.82	2.01	2.60	2.29	2.94	2.48	1.96	2.20	0.82	45.00	3	20
Social and religious professionals	263	1.34	1.79	2.40	2.13	2.62	2.16	1.75	2.53	0.19	68.42	1	19
Authors, journalists and linguists	264	1.69	2.37	2.48	2.06	3.02	1.75	1.75	2.17	1.03	47.06	2	17
Physical and engineering science technicians	311	2.81	2.07	2.36	1.93	2.23	1.68	1.75	2.22	0.88	28.95	4	38
Mining, manufacturing and construction supervisors	312	2.19	2.02	2.13	1.83	2.10	2.64	3.73	2.54	0.46	14.06	4	64
Process control technicians	313	1.92	1.45	1.47	1.85	1.88	1.54	1.75	2.21	-0.64	8.70	3	23
Medical and pharmaceutical technicians	321	1.91	1.28	1.87	2.04	1.95	1.87	1.75	1.88	-0.94	76.47	3	17
Other health associate professionals	325	1.55	2.02	2.30	1.77	1.84	1.80	2.05	2.18	-0.62	63.16	2	19
Financial and mathematical associate professionals	331	2.77	2.30	2.36	1.56	2.33	1.84	1.75	1.99	0.94	67.65	4	34
Sales and purchasing agents and brokers	332	2.65	2.39	2.50	1.85	2.07	2.17	1.75	2.23	0.81	50.00	4	60
Business services agents	333	2.08	2.62	2.85	1.93	2.13	2.11	1.75	2.56	0.82	75.00	3	20
Administrative and specialised secretaries	334	1.68	1.92	2.22	1.83	1.98	2.10	1.78	2.07	-0.51	80.39	2	51
Regulatory government associate professionals	335	1.76	2.08	2.28	2.07	2.48	2.17	1.75	2.44	0.49	40.91	2	66
Legal, social and religious associate professionals	341	1.68	2.02	2.31	2.17	2.25	2.15	2.41	2.47	0.16	76.67	2	30
Artistic, cultural and culinary associate professionals	343	1.49	1.61	2.05	1.45	2.23	1.78	1.75	1.81	-0.81	31.58	2	19
Information and communications technology operations and user support technicians	351	1.90	2.62	2.21	2.17	2.38	2.01	1.77	2.07	0.58	26.32	3	19
General office clerks	411	1.88	2.07	2.39	1.61	1.86	1.70	1.75	1.93	-0.50	76.92	3	117
Secretaries (general)	412	2.10	1.86	1.79	1.42	1.77	1.27	1.96	2.06	-0.46	92.86	3	14
Tellers, money collectors and related clerks	421	1.93	1.76	1.80	2.12	2.26	2.17	1.75	2.07	-0.12	86.96	3	23
Client information workers	422	1.82	2.38	2.21	1.90	1.90	1.95	1.75	1.93	-0.29	63.89	3	36
Numerical clerks	431	2.19	2.23	2.13	1.83	1.89	1.69	1.75	2.07	0.01	76.47	4	34
Material-recording and transport clerks	432	1.31	1.49	1.80	1.57	1.59	1.39	1.75	1.78	-1.75	22.92	1	96
Other clerical support workers	441	1.63	1.96	2.06	1.79	1.64	1.59	1.75	1.92	-1.01	51.06	2	47
Cooks	512	0.97	0.44	1.79	2.13	1.45	1.41	1.75	1.00	-3.50	53.33	1	15
Waiters and bartenders	513	1.37	0.60	2.13	1.72	1.20	1.84	1.75	1.62	-2.87	45.45	1	11
Hairdressers, beauticians and related workers	514	1.55	1.46	2.40	1.96	1.83	1.96	1.75	1.17	-1.80	87.50	2	24
Building and housekeeping supervisors	515	1.62	2.01	2.31	1.75	1.39	1.53	1.75	1.86	-1.31	46.15	2	13
Shop salespersons	522	1.95	1.57	2.21	2.01	2.05	2.17	1.75	1.77	-0.70	72.81	3	114
Cashiers and ticket clerks	523	1.55	1.13	1.39	1.60	1.35	1.70	1.42	1.39	-2.38	80.77	2	26

Child care workers and teachers' aides	531	0.94	1.17	1.96	1.81	1.63	1.45	1.44	1.77	-2.25	93.33	1	45
Personal care workers in health services	532	0.97	1.26	1.78	1.85	1.72	1.84	1.75	2.07	-1.82	87.37	1	95
Protective services workers	541	1.39	1.53	1.71	1.92	2.14	2.17	1.62	2.99	-0.13	29.17	1	24
Market gardeners and crop growers	611	1.82	0.99	1.95	2.16	2.17	1.93	1.75	1.66	-1.15	23.53	3	17
Animal producers	612	1.83	1.39	2.73	1.52	2.36	1.27	1.75	1.39	-0.87	58.33	3	12
Building frame and related trades workers	711	1.51	1.35	2.03	1.90	1.18	1.43	1.43	1.17	-2.63	0.00	2	64
Building finishers and related trades workers	712	1.43	1.16	2.13	1.75	1.36	1.59	1.75	1.55	-2.32	2.22	2	45
Painters, building structure cleaners and related trades workers	713	1.87	1.37	1.94	1.85	1.68	1.75	1.37	1.39	-1.59	5.88	3	17
Sheet and structural metal workers, moulders and welders, and related workers	721	0.96	0.72	1.54	1.83	1.21	1.18	1.49	1.00	-3.58	7.89	1	38
Machinery mechanics and repairers	723	1.63	1.22	2.13	1.90	1.99	1.48	1.75	1.77	-1.26	1.64	2	61
Handicraft workers	731	2.25	1.60	2.31	0.63	1.34	2.37	1.96	2.01	-1.03	45.45	4	11
Electrical equipment installers and repairers	741	1.62	1.44	2.06	2.04	1.80	1.41	1.75	2.23	-0.96	2.70	2	37
Electronics and telecommunications installers and repairers	742	1.55	1.48	2.03	2.01	1.83	1.50	1.75	2.38	-0.85	7.14	2	14
Food processing and related trades workers	751	1.97	1.00	2.31	2.15	2.07	2.52	3.01	1.60	-1.17	18.75	3	16
Wood treaters, cabinet-makers and related trades workers	752	1.98	1.78	2.00	1.74	1.52	1.48	1.75	1.08	-1.65	0.00	3	13
Other stationary plant and machine operators	818	1.37	0.98	1.35	2.05	1.54	1.14	1.42	1.92	-2.00	14.29	1	14
Assemblers	821	0.90	1.03	1.78	1.76	1.11	1.72	1.43	1.00	-3.52	13.79	1	29
Car, van and motorcycle drivers	832	0.96	1.20	1.47	1.58	1.11	0.32	1.18	1.48	-3.00	11.11	1	18
Heavy truck and bus drivers	833	1.20	0.98	1.82	1.73	1.48	0.99	1.75	1.72	-2.36	8.20	1	61
Mobile plant operators	834	1.20	0.73	1.67	1.77	0.98	0.98	1.56	1.27	-3.43	0.00	1	32
Domestic, hotel and office cleaners and helpers	911	0.85	0.98	2.13	1.53	0.78	0.68	1.75	1.00	-3.97	97.50	1	120
Vehicle, window, laundry and other hand cleaning workers	912	0.97	1.18	1.71	1.82	0.73	0.92	1.75	1.25	-3.59	68.75	1	16
Mining and construction labourers	931	0.51	1.30	1.95	1.80	1.07	0.99	1.22	1.60	-3.24	0.00	1	14
Manufacturing labourers	932	1.39	0.59	0.69	1.43	0.62	0.11	0.92	1.00	-3.97	60.00	1	25
Transport and storage labourers	933	0.96	0.85	1.43	1.61	1.56	1.23	1.14	1.22	-2.95	31.58	1	19
Food preparation assistants	941	1.34	1.53	1.39	1.64	0.79	0.66	1.75	1.22	-3.02	89.47	1	19
Other elementary workers	962	1.00	1.24	2.13	1.80	1.38	1.30	1.75	1.36	-2.73	12.90	1	31
CZECH REPUBLIC	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Managing directors and chief executives	112	3.07	2.80	3.73	1.72	2.81	2.58	3.73	2.07	2.11	17.39	4	23

Business services and administration managers	121	2.77	2.62	2.60	2.15	2.67	2.90	3.73	2.44	1.88	51.72	4	29
Sales, marketing and development managers	122	3.14	2.90	2.95	2.26	2.62	2.58	3.01	2.40	2.28	41.94	4	31
Manufacturing, mining, construction, and distribution managers	132	2.97	2.32	2.60	1.97	2.60	2.68	3.73	2.70	1.96	12.50	4	48
Information and communications technology service managers	133	2.73	3.49	2.92	2.57	2.61	2.53	3.01	2.72	2.59	12.50	4	16
Professional services managers	134	2.16	2.32	2.51	2.04	2.78	2.77	3.73	2.57	1.40	87.50	3	24
Hotel and restaurant managers	141	2.27	1.73	2.51	1.52	1.79	1.93	1.75	1.52	-0.80	73.33	3	15
Retail and wholesale trade managers	142	2.98	2.20	3.07	2.25	2.44	2.38	3.73	2.01	1.16	45.45	4	22
Other services managers	143	2.55	2.62	2.76	2.09	2.37	2.65	3.73	2.63	1.53	38.46	4	26
Engineering professionals (excluding electrotechnology)	214	2.96	2.08	2.27	2.01	2.34	1.99	2.41	2.07	1.01	6.82	4	44
Architects, planners, surveyors and designers	216	3.30	2.39	2.46	1.61	2.74	2.80	2.71	2.76	2.48	41.67	4	12
Medical doctors	221	1.57	1.41	1.63	1.93	2.46	2.57	1.85	2.55	-0.04	64.71	1	17
Nursing and midwifery professionals	222	1.57	1.11	1.94	1.96	2.06	2.21	3.01	1.84	-1.25	100.00	1	64
Other health professionals	226	2.01	1.49	2.43	1.45	2.29	2.17	1.75	2.10	-0.18	78.26	3	23
University and higher education teachers	231	2.34	2.27	2.57	1.83	2.75	2.75	1.96	2.13	1.15	40.00	3	15
Secondary education teachers	233	2.25	1.92	1.78	1.83	2.68	3.90	3.73	1.97	0.63	57.58	3	33
Primary school and early childhood teachers	234	1.65	1.57	1.95	1.61	2.24	2.40	3.01	2.01	-0.54	77.46	1	71
Other teaching professionals	235	1.42	1.76	2.21	2.05	2.48	2.39	3.01	2.00	-0.33	83.78	1	37
Finance professionals	241	3.26	2.67	2.39	2.09	2.64	2.11	1.96	2.32	2.19	66.67	4	24
Administration professionals	242	2.22	2.50	2.48	1.79	2.51	2.17	3.01	2.28	1.06	66.67	3	24
Sales, marketing and public relations professionals	243	2.24	2.93	2.40	1.79	2.60	2.25	2.71	2.88	1.94	27.78	3	18
Software and applications developers and analysts	251	2.59	2.32	2.41	2.05	2.52	1.76	1.75	2.33	1.28	10.26	4	39
Legal professionals	261	1.83	2.32	2.80	2.13	3.17	2.41	3.01	2.14	1.25	42.11	2	19
Authors, journalists and linguists	264	1.94	2.10	2.43	1.78	2.38	2.08	1.75	2.70	0.75	61.54	3	13
Creative and performing artists	265	1.74	1.68	2.82	2.03	2.08	1.52	3.07	2.01	-0.57	47.06	2	17
Physical and engineering science technicians	311	2.77	2.32	2.31	1.90	2.34	2.11	1.87	2.33	1.22	21.51	4	93
Mining, manufacturing and construction supervisors	312	2.61	1.64	2.13	2.21	1.84	2.61	3.73	2.48	0.21	5.88	4	34
Medical and pharmaceutical technicians	321	1.98	1.12	2.08	1.75	2.22	1.91	1.75	1.44	-1.03	100.00	3	18
Financial and mathematical associate professionals	331	3.11	2.45	2.60	1.93	2.49	2.17	1.75	2.33	1.76	70.59	4	119
Sales and purchasing agents and brokers	332	2.91	2.62	2.59	2.01	2.31	2.40	1.96	2.48	1.63	40.24	4	82

Business services agents	333	2.46	2.10	2.40	1.93	2.20	2.11	1.75	2.22	0.59	76.00	3	25
Administrative and specialised secretaries	334	2.00	2.04	2.21	1.48	2.00	1.70	1.75	2.39	0.09	92.31	3	13
Regulatory government associate professionals	335	2.07	2.02	2.30	2.13	2.36	1.74	1.75	2.23	0.41	65.22	3	46
Legal, social and religious associate professionals	341	1.69	1.76	2.21	1.94	2.06	2.11	1.75	2.33	-0.33	82.76	2	29
Artistic, cultural and culinary associate professionals	343	1.87	2.00	2.60	2.44	2.24	2.09	2.41	1.41	-0.53	57.89	2	19
Information and communications technology operations and user support technicians	351	2.19	2.75	2.40	2.11	2.57	1.95	1.96	2.13	1.15	3.51	3	57
General office clerks	411	2.50	2.41	2.06	1.93	2.20	1.90	1.75	2.31	0.90	85.25	4	61
Secretaries (general)	412	2.47	2.59	2.40	1.57	2.19	1.83	2.18	2.38	1.04	90.63	4	32
Client information workers	422	2.29	2.30	1.78	1.93	1.90	2.17	1.75	2.00	0.09	87.50	3	40
Numerical clerks	431	2.80	2.30	2.40	1.73	2.29	1.52	1.75	1.93	0.88	97.26	4	73
Material-recording and transport clerks	432	2.42	1.75	2.13	1.82	1.91	1.89	2.41	1.93	-0.22	40.58	3	69
Other clerical support workers	441	1.75	1.92	2.04	1.86	2.20	2.00	1.75	1.93	-0.33	77.08	2	48
Cooks	512	1.89	1.48	2.22	1.72	1.56	1.60	1.75	1.00	-1.94	50.00	2	40
Waiters and bartenders	513	1.88	0.71	2.05	1.53	1.51	2.17	1.75	0.76	-2.72	74.19	2	31
Hairdressers, beauticians and related workers	514	1.88	1.45	3.06	2.05	1.92	1.95	1.75	1.56	-1.14	90.32	2	31
Building and housekeeping supervisors	515	2.00	1.53	2.22	1.60	1.91	1.90	1.75	1.91	-0.73	33.33	3	33
Shop salespersons	522	2.24	1.36	2.13	1.91	1.71	2.17	1.75	1.00	-1.58	79.02	3	143
Cashiers and ticket clerks	523	1.82	1.39	1.35	2.15	1.57	1.50	1.75	1.48	-1.67	100.00	2	19
Other sales workers	524	2.87	2.62	2.40	1.97	2.27	2.17	1.75	1.91	1.11	48.15	4	81
Personal care workers in health services	532	1.64	1.04	1.66	2.78	2.02	1.90	1.75	1.76	-1.34	80.00	1	10
Protective services workers	541	1.37	1.37	1.95	1.83	2.12	1.90	1.75	2.15	-0.93	23.08	1	78
Market gardeners and crop growers	611	0.96	0.73	2.40	1.38	1.63	1.52	1.75	1.11	-3.03	53.33	1	15
Building frame and related trades workers	711	1.84	1.35	2.40	1.72	1.21	1.60	1.75	0.97	-2.47	0.00	2	60
Building finishers and related trades workers	712	1.86	1.53	1.86	1.53	1.47	1.73	1.75	1.00	-2.03	0.00	2	35
Sheet and structural metal workers, moulders and welders, and related workers	721	1.81	1.52	1.71	1.20	1.24	1.30	1.75	1.00	-2.33	9.68	2	31
Blacksmiths, toolmakers and related trades workers	722	1.89	0.76	2.16	1.70	1.56	1.29	1.75	1.00	-2.43	2.50	2	40
Machinery mechanics and repairers	723	1.69	1.09	2.13	2.01	1.85	1.59	1.75	1.72	-1.48	2.80	2	107
Electrical equipment installers and repairers	741	1.90	1.28	2.39	2.01	2.02	1.65	1.75	1.80	-0.94	0.00	2	30
Food processing and related trades workers	751	1.74	2.17	1.81	2.03	0.91	1.22	1.44	1.00	-2.30	80.00	2	20

Wood treaters, cabinet-makers and related trades workers	752	2.39	1.39	2.64	1.82	1.93	1.84	3.01	1.59	-0.74	8.33	3	24
Garment and related trades workers	753	1.54		1.74	1.38	1.30	1.15	1.75	0.88		88.24	1	17
Other craft and related workers	754	1.66	1.10	1.13	1.64	1.51	1.26	1.75	1.00	-2.44	64.52	1	31
Metal processing and finishing plant operators	812	2.18	1.15	1.62	1.72	1.42	1.28	1.75	1.63	-1.59	14.29	3	42
Rubber, plastic and paper products machine operators	814	1.41	0.67	1.13	1.53	1.24	0.99	1.37	1.41	-2.92	33.33	1	24
Other stationary plant and machine operators	818	1.66	0.85	1.32	1.93	1.24	1.15	1.75	1.00	-2.91	48.65	1	37
Assemblers	821	1.66	1.36	1.87	1.94	1.25	1.32	1.75	1.00	-2.54	53.85	1	65
Locomotive engine drivers and related workers	831	1.91	0.86	1.09	1.43	1.88	0.65	1.25	1.27	-1.79	28.57	3	14
Car, van and motorcycle drivers	832	1.71	1.13	2.17	1.53	1.60	1.85	1.75	1.00	-2.27	7.69	2	26
Heavy truck and bus drivers	833	1.66	1.09	1.31	1.61	1.51	1.35	1.75	1.00	-2.44	0.00	1	67
Mobile plant operators	834	1.66	0.94	1.87	1.44	1.45	1.47	1.75	1.03	-2.59	10.17	1	59
Domestic, hotel and office cleaners and helpers	911	0.75	1.12	2.13	1.03	0.68	0.99	1.75	0.47	-4.48	97.92	1	48
Agricultural, forestry and fishery labourers	921	0.96		1.78	0.94	1.04	0.82	1.75	0.75		64.29	1	14
Mining and construction labourers	931	1.31	1.12	2.04	1.80	0.88	1.10	1.75	0.95	-3.44	0.00	1	15
Manufacturing labourers	932	1.54	0.61	1.25	1.56	0.66	0.79	1.58	1.00	-3.81	68.29	1	41
Transport and storage labourers	933	1.20	0.83	1.63	1.64	1.20	0.99	1.75	1.00	-3.33	30.00	1	20
Food preparation assistants	941	0.96		1.38	2.26	0.85	0.98	1.75	1.00		92.31	1	13
Other elementary workers	962	1.77	1.20	1.65	0.90	1.11	0.99	1.56	0.59	-3.04	33.33	2	12
DENMARK	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Armed forces occupations, other ranks	31	1.55	1.95	2.13	2.44	2.28	2.19	1.86	1.77	-0.50	9.09	2	11
Business services and administration managers	121	2.88	2.78	3.22	2.05	2.83	2.73	3.01	2.24	2.10	37.14	4	70
Sales, marketing and development managers	122	2.85	2.80	2.80	2.23	2.82	3.02	3.01	2.33	2.15	18.18	4	22
Manufacturing, mining, construction, and distribution managers	132	2.37	2.37	2.60	2.04	2.62	2.91	3.73	2.13	1.10	19.51	4	41
Professional services managers	134	2.15	2.45	2.59	2.17	2.87	3.05	3.01	2.51	1.54	50.46	3	109
Retail and wholesale trade managers	142	3.04	2.22	2.65	2.23	2.87	2.81	3.01	2.33	1.97	18.75	4	16
Other services managers	143	2.37	2.29	2.60	1.96	2.77	2.85	3.73	2.29	1.33	29.41	4	17
Physical and earth science professionals	211	1.31	1.42	2.12	2.05	2.29	2.28	1.75	2.14	-0.75	75.96	1	104
Life science professionals	213	2.28	2.54	1.88	2.12	2.78	2.34	2.71	2.30	1.45	50.00	4	12
Engineering professionals (excluding electrotechnology)	214	3.24	2.85	2.42	2.07	2.73	2.37	1.96	2.27	2.35	13.89	4	72

Electrotechnology engineers	215	3.75	3.31	2.31	2.12	2.77	2.23	1.96	2.35	3.17	13.33	4	15
Architects, planners, surveyors and designers	216	2.08	2.32	2.30	1.85	2.51	2.17	1.96	1.91	0.54	49.06	3	53
Medical doctors	221	2.23	1.76	1.79	2.44	2.79	2.85	2.05	2.47	1.03	42.31	4	52
Nursing and midwifery professionals	222	1.70	1.38	2.05	2.17	2.42	2.41	1.96	2.62	0.05	95.45	2	110
Other health professionals	226	1.62	1.78	2.40	2.16	2.41	2.35	1.75	2.19	-0.09	74.03	2	77
University and higher education teachers	231	2.43	2.64	2.71	2.17	2.96	2.39	2.23	2.35	1.87	60.87	4	46
Vocational education teachers	232	2.16	2.30	2.40	2.44	3.08	2.93	1.96	1.97	1.26	27.59	4	29
Secondary education teachers	233	2.06	2.23	2.31	2.12	3.05	3.28	3.01	2.01	1.13	38.10	3	42
Primary school and early childhood teachers	234	1.53	1.62	2.04	2.13	2.34	2.78	1.96	1.74	-0.70	75.75	1	268
Other teaching professionals	235	1.70	2.00	2.31	2.05	2.68	2.80	2.23	1.97	0.25	48.44	2	64
Finance professionals	241	2.87	2.93	2.40	2.16	2.82	2.32	1.75	2.21	2.16	48.86	4	88
Administration professionals	242	2.12	2.69	2.51	2.30	2.60	2.41	2.23	2.27	1.21	50.00	3	46
Sales, marketing and public relations professionals	243	2.33	3.04	2.50	2.30	2.53	2.41	1.96	2.28	1.54	40.38	4	52
Software and applications developers and analysts	251	2.36	2.86	2.31	2.06	2.47	2.16	1.75	2.17	1.28	20.83	4	96
Database and network professionals	252	2.08	3.50	2.40	2.30	2.73	2.45	2.41	2.21	1.81	18.60	3	43
Legal professionals	261	1.85	2.10	2.50	2.23	2.78	2.42	1.96	1.97	0.54	41.38	2	29
Librarians, archivists and curators	262	1.46	2.52	2.69	2.21	2.50	2.15	1.96	2.20	0.40	75.00	1	16
Social and religious professionals	263	1.31	1.92	2.60	2.04	2.40	2.32	1.75	2.27	-0.20	72.13	1	61
Authors, journalists and linguists	264	1.89	2.54	2.50	2.10	2.68	2.02	1.75	2.42	1.12	54.29	2	35
Creative and performing artists	265	1.90	1.81	2.51	2.06	2.37	1.99	1.75	2.11	0.05	45.00	3	20
Physical and engineering science technicians	311	2.15	2.11	2.28	1.74	2.26	1.82	1.75	2.07	0.30	46.94	4	98
Mining, manufacturing and construction supervisors	312	2.09	2.10	2.71	2.16	2.30	2.96	3.73	2.11	0.31	11.76	3	17
Process control technicians	313	2.89	2.15	2.70	1.80	2.82	2.28	2.18	2.30	1.71	16.67	4	24
Ship and aircraft controllers and technicians	315	2.19	1.76	1.40	1.90	2.62	1.89	2.05	2.38	0.73	10.00	4	20
Medical and pharmaceutical technicians	321	2.05	1.73	2.11	2.07	2.45	2.24	1.75	1.85	0.00	76.47	3	34
Nursing and midwifery associate professionals	322	0.97	1.27	1.58	1.63	2.07	1.69	1.75	2.01	-1.47	88.24	1	17
Other health associate professionals	325	0.91	1.24	1.47	1.78	2.25	1.97	1.75	2.55	-0.92	60.71	1	28
Financial and mathematical associate professionals	331	2.63	2.32	2.32	1.74	2.46	1.55	1.75	1.97	0.97	56.25	4	32
Sales and purchasing agents and brokers	332	2.66	2.53	2.75	2.05	2.49	2.44	1.75	2.21	1.36	25.51	4	98

Business services agents	333	2.40	2.54	2.60	1.99	2.38	2.32	2.41	2.27	1.09	34.00	4	50
Administrative and specialised secretaries	334	1.59	2.30	2.40	1.96	2.50	2.20	1.96	2.10	0.27	83.12	2	77
Regulatory government associate professionals	335	1.65	2.23	2.31	2.04	2.84	1.84	1.75	2.36	0.84	61.90	2	21
Legal, social and religious associate professionals	341	1.58	1.98	2.22	2.41	2.42	2.57	1.96	2.19	0.03	63.64	2	33
Sports and fitness workers	342	1.45	1.23	2.93	2.05	1.80	2.74	1.49	1.36	-1.92	35.71	1	14
Artistic, cultural and culinary associate professionals	343	2.00	1.87	2.82	2.07	2.49	2.26	2.41	1.93	0.16	71.88	3	32
Information and communications technology operations and user support technicians	351	1.88	2.80	2.27	2.23	2.54	2.23	1.75	2.14	0.91	25.00	2	24
General office clerks	411	1.70	2.32	2.30	1.73	2.06	1.63	1.75	1.95	-0.22	77.78	2	36
Secretaries (general)	412	1.50	2.06	2.61	1.89	2.05	1.82	1.75	1.82	-0.68	95.83	1	24
Tellers, money collectors and related clerks	421	2.13	2.15	1.92	1.91	2.23	2.18	1.75	1.85	0.11	81.25	3	16
Client information workers	422	1.70	2.30	2.10	1.80	2.23	2.10	1.96	1.77	-0.20	75.00	2	32
Numerical clerks	431	2.37	2.49	2.31	1.64	2.15	1.94	1.75	1.91	0.48	75.22	4	113
Material-recording and transport clerks	432	2.11	2.02	2.39	1.64	2.15	1.99	1.96	1.89	-0.05	27.78	3	36
Other clerical support workers	441	1.68	1.91	2.10	1.83	2.10	1.89	1.75	1.59	-0.77	71.43	2	70
Cooks	512	1.70	1.18	2.15	2.30	1.84	2.22	2.48	1.14	-1.88	47.37	2	19
Waiters and bartenders	513	1.96	1.07	1.97	1.85	1.69	1.89	1.32	1.53	-1.60	71.43	3	14
Hairdressers, beauticians and related workers	514	1.57	1.22	2.40	1.90	2.19	2.34	1.96	1.41	-1.36	84.21	2	19
Building and housekeeping supervisors	515	1.91	1.76	2.40	1.42	1.85	1.70	2.08	2.29	-0.40	25.93	3	27
Other personal services workers	516	1.90	1.38	2.40	2.11	2.26	2.15	1.75	1.90	-0.53	28.57	3	21
Shop salespersons	522	2.28	1.86	2.40	2.04	2.20	2.38	1.96	1.93	0.06	50.67	4	150
Cashiers and ticket clerks	523	1.55	1.11	1.63	1.74	1.60	1.73	1.75	1.09	-2.36	66.67	2	33
Other sales workers	524	2.14	1.92	1.97	2.17	2.26	2.17	1.75	1.99	0.10	47.83	3	23
Child care workers and teachers' aides	531	1.06	1.17	2.22	2.12	1.85	1.72	1.61	1.42	-2.17	74.67	1	75
Personal care workers in health services	532	1.22	1.17	2.04	2.05	2.07	1.98	1.75	2.50	-0.96	87.56	1	201
Protective services workers	541	0.92	1.62	1.64	1.93	2.30	1.71	1.75	2.56	-0.60	30.77	1	26
Market gardeners and crop growers	611	1.99	1.33	3.07	1.93	2.37	1.73	1.96	1.36	-0.79	20.45	3	44
Animal producers	612	1.98	1.50	2.48	1.85	2.70	2.13	3.01	1.52	-0.19	25.00	3	28
Mixed crop and animal producers	613	1.99	1.18	3.22	1.72	2.61	1.55	1.96	1.06	-0.86	12.50	3	24
Building frame and related trades workers	711	2.01	1.38	2.13	1.59	1.71	1.91	1.96	1.32	-1.50	2.15	3	93

Building finishers and related trades workers	712	1.50	1.15	2.22	1.82	1.94	1.47	1.75	1.35	-1.79	0.00	1	26
Painters, building structure cleaners and related trades workers	713	1.65	1.34	2.65	1.25	1.67	1.59	1.75	1.41	-1.79	23.08	2	26
Sheet and structural metal workers, moulders and welders, and related workers	721	1.48	0.86	1.86	1.49	1.47	1.26	1.75	1.22	-2.63	16.67	1	12
Blacksmiths, toolmakers and related trades workers	722	1.93	1.30	2.14	1.59	1.71	1.67	1.75	1.52	-1.46	1.96	3	51
Machinery mechanics and repairers	723	1.66	1.25	2.31	2.17	2.11	1.99	1.75	1.93	-0.96	3.45	2	58
Handicraft workers	731	2.11	1.93	2.22	1.77	2.21	1.69	1.75	1.82	-0.10	36.36	3	11
Electrical equipment installers and repairers	741	1.96	1.24	2.06	1.89	2.28	1.66	1.75	1.90	-0.56	2.44	3	41
Electronics and telecommunications installers and repairers	742	2.37	2.15	1.79	2.41	2.00	1.32	1.75	1.55	-0.18	33.33	4	12
Food processing and related trades workers	751	2.06	1.42	2.04	1.86	1.93	2.07	2.71	1.77	-0.84	19.05	3	21
Other craft and related workers	754	2.15	2.08	2.31	2.17	2.19	2.39	1.96	2.19	0.29	63.16	4	19
Metal processing and finishing plant operators	812	2.06	0.81	1.78	1.85	1.30	1.11	1.75	1.22	-2.38	14.29	3	14
Rubber, plastic and paper products machine operators	814	1.53	0.95	1.39	1.89	2.00	1.20	1.75	1.20	-1.95	33.33	1	12
Food and related products machine operators	816	1.31	1.28	1.87	1.49	1.96	1.45	1.75	2.73	-0.77	27.78	1	18
Other stationary plant and machine operators	818	1.66	1.16	1.47	1.64	1.63	1.06	1.41	1.61	-1.79	22.58	2	31
Assemblers	821	1.57	1.15	2.07	1.64	1.98	1.88	1.75	1.86	-1.28	26.32	2	19
Locomotive engine drivers and related workers	831	1.20	1.37	1.21	1.84	2.15	1.29	1.49	2.13	-1.04	10.00	1	10
Car, van and motorcycle drivers	832	1.36	0.95	2.04	1.47	1.57	0.94	1.56	1.41	-2.40	4.35	1	23
Heavy truck and bus drivers	833	1.20	1.17	1.63	1.44	1.61	1.36	1.75	1.70	-2.10	6.78	1	59
Mobile plant operators	834	1.30	1.30	2.14	1.53	1.77	1.18	1.75	1.35	-2.03	0.00	1	17
Domestic, hotel and office cleaners and helpers	911	1.55	1.21	2.22	1.05	1.40	1.12	1.75	0.94	-2.62	77.32	2	97
Vehicle, window, laundry and other hand cleaning workers	912	1.83	1.46	2.14	1.56	1.33	1.42	1.75	1.00	-2.24	65.22	2	23
Mining and construction labourers	931	1.52	1.09	2.15	1.64	1.61	1.62	1.75	1.55	-2.02	0.00	1	33
Manufacturing labourers	932	1.52	0.94	1.25	1.53	1.34	1.19	0.92	2.24	-1.88	50.00	1	18
Transport and storage labourers	933	1.438813	1.20	2.13	1.74	1.68	1.57	1.75	1.22	-2.20	29.51	1.00	61
Food preparation assistants	941	1.59802	0.98	2.04	1.75	1.69	1.55	1.75	1.00	-2.37	69.70	2.00	33
Refuse workers	961	0.8215994	1.13	1.71	1.64	1.14	1.29	1.86	1.36	-3.22	0.00	1.00	10
Other elementary workers	962	1.538475	1.31	2.48	1.53	1.63	1.57	1.75	1.27	-2.06	17.24	2.00	29
FRANCE	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Legislators and senior officials	111	1.80	2.02	1.95	2.07	2.77	2.08	3.01	2.49	0.84	40.00	2	15

Business services and administration managers	121	2.89	2.38	2.40	2.25	2.60	2.34	3.01	2.26	1.61	57.14	4	56
Sales, marketing and development managers	122	2.71	2.75	2.26	2.13	2.69	2.50	2.41	2.40	1.92	25.00	4	24
Manufacturing, mining, construction, and distribution managers	132	3.26	2.44	2.21	2.30	2.38	2.70	3.01	2.43	1.82	16.67	4	84
Information and communications technology service managers	133	2.47	2.72	2.20	2.17	2.36	2.49	3.01	2.53	1.44	18.18	4	33
Professional services managers	134	2.40	2.14	2.04	2.37	2.75	2.62	1.96	2.38	1.29	50.00	4	70
Hotel and restaurant managers	141	2.21	2.13	2.71	1.96	2.23	3.17	3.01	2.25	0.47	27.27	4	11
Retail and wholesale trade managers	142	2.67	1.88	2.29	2.44	2.47	2.70	3.37	2.54	1.17	26.92	4	26
Non-commissioned armed forces officers	210	0.93	1.72	1.78	2.46	2.33	2.17	1.50	2.38	-0.63	10.00	1	10
Engineering professionals (excluding electrotechnology)	214	3.02	2.62	2.31	2.13	2.56	2.04	1.75	2.38	1.91	31.11	4	45
Architects, planners, surveyors and designers	216	2.45	2.05	1.86	1.93	2.63	1.86	1.75	1.88	0.76	37.04	4	27
Medical doctors	221	1.61	1.21	1.83	1.94	2.59	1.92	1.75	2.51	-0.04	62.50	2	16
Nursing and midwifery professionals	222	1.62	1.23	1.47	2.54	2.13	2.55	3.73	2.23	-0.74	85.45	2	55
Other health professionals	226	1.63	1.64	1.91	2.17	2.50	1.94	1.75	2.08	-0.17	64.29	2	28
University and higher education teachers	231	2.90	2.62	2.13	1.99	2.96	2.57	1.96	2.05	2.00	50.00	4	14
Vocational education teachers	232	2.03	1.87	1.88	2.01	2.63	2.37	1.86	1.80	0.24	25.00	3	20
Secondary education teachers	233	1.82	1.76	1.54	2.17	2.58	3.47	3.73	1.97	0.08	61.39	3	101
Primary school and early childhood teachers	234	1.83	1.82	1.39	2.21	2.65	2.81	2.58	2.07	0.27	81.63	3	49
Other teaching professionals	235	1.75	1.43	2.22	2.79	1.96	2.76	1.75	1.64	-1.15	54.55	2	11
Finance professionals	241	3.33	2.62	2.31	2.10	2.35	1.94	1.75	2.21	1.80	48.15	4	27
Administration professionals	242	2.25	2.32	2.40	2.17	2.56	2.14	1.75	2.23	0.98	55.32	4	47
Sales, marketing and public relations professionals	243	2.84	2.62	2.20	2.21	2.34	2.30	1.75	2.35	1.50	43.55	4	62
Software and applications developers and analysts	251	2.27	2.50	2.06	2.05	2.28	1.76	1.75	2.19	0.78	25.00	4	40
Legal professionals	261	2.42	2.07	2.40	2.30	2.80	2.51	2.41	2.79	1.63	52.94	4	17
Social and religious professionals	263	1.58	1.84	2.31	2.08	2.59	2.21	1.75	1.89	-0.12	68.42	2	19
Creative and performing artists	265	1.43	1.92	2.33	2.30	2.31	1.86	1.80	1.59	-0.73	36.36	1	22
Armed forces occupations, other ranks	310	1.77	1.77	1.58	2.44	2.33	2.12	1.75	2.72	0.34	27.78	2	18
Physical and engineering science technicians	311	2.06	1.84	1.80	2.04	2.12	1.75	1.75	2.05	-0.12	10.81	3	111
Mining, manufacturing and construction supervisors	312	2.01	1.32	1.54	2.25	1.71	2.10	3.01	1.93	-1.07	7.69	3	143
Process control technicians	313	2.06	1.56	1.86	2.16	1.97	1.63	1.75	2.23	-0.34	15.00	3	40

Medical and pharmaceutical technicians	321	1.76	1.15	1.22	2.28	2.02	1.62	1.75	1.55	-1.34	79.17	2	24
Nursing and midwifery associate professionals	322	1.65	1.06	1.52	2.26	2.00	2.16	1.75	1.99	-1.17	81.08	2	37
Other health associate professionals	325	2.08	1.30	1.66	2.37	2.03	1.97	1.75	1.77	-0.80	60.87	3	23
Financial and mathematical associate professionals	331	2.79	2.01	2.06	2.07	2.07	1.80	1.75	1.88	0.38	75.56	4	45
Sales and purchasing agents and brokers	332	2.50	1.92	2.13	2.33	2.28	2.29	1.75	1.93	0.36	55.29	4	85
Business services agents	333	2.37	2.10	2.06	2.35	2.47	2.00	1.75	1.97	0.61	38.10	4	21
Administrative and specialised secretaries	334	2.12	2.32	2.13	2.07	2.16	1.95	1.75	2.14	0.36	82.71	3	133
Regulatory government associate professionals	335	1.90	2.01	1.80	2.30	2.26	1.75	1.71	2.10	0.05	70.83	3	24
Legal, social and religious associate professionals	341	1.69	1.72	1.79	2.25	2.04	2.12	1.75	2.21	-0.46	72.63	2	95
Sports and fitness workers	342	1.69	1.27	1.86	1.79	2.22	2.51	1.75	1.93	-0.80	46.15	2	13
Artistic, cultural and culinary associate professionals	343	1.76	1.90	2.13	2.08	2.33	2.15	1.75	1.41	-0.59	36.36	2	22
Information and communications technology operations and user support technicians	351	1.89	2.85	2.31	1.92	2.38	1.76	1.75	2.42	1.00	27.27	3	11
Telecommunications and broadcasting technicians	352	2.03	1.88	1.63	2.15	1.85	1.76	1.75	2.25	-0.27	10.00	3	20
General office clerks	411	1.92	1.92	1.86	2.07	1.94	1.58	1.75	1.93	-0.48	78.57	3	98
Secretaries (general)	412	1.90	1.88	1.92	2.05	1.82	1.40	1.75	1.59	-0.91	100.00	3	59
Tellers, money collectors and related clerks	421	2.49	1.45	1.40	2.57	2.16	2.38	1.75	1.93	-0.10	60.00	4	15
Client information workers	422	1.55	1.72	1.33	1.75	1.76	1.75	1.59	1.91	-1.13	72.73	1	22
Numerical clerks	431	2.37	2.02	2.02	1.70	1.78	1.44	1.75	1.73	-0.38	87.01	4	77
Material-recording and transport clerks	432	1.69	1.80	1.80	2.05	2.20	2.34	1.75	1.93	-0.45	32.50	2	40
Other clerical support workers	441	1.16	2.23	1.47	1.85	1.87	0.99	1.59	1.91	-0.97	53.85	1	26
Cooks	512	1.65	1.21	1.31	1.93	1.91	1.80	1.75	1.17	-1.80	27.78	2	54
Waiters and bartenders	513	1.48	0.96	1.11	1.77	1.12	2.08	1.65	1.74	-2.53	57.69	1	26
Hairdressers, beauticians and related workers	514	1.55	1.04	1.61	1.77	1.91	2.05	1.75	1.17	-2.00	100.00	1	39
Building and housekeeping supervisors	515	1.01	1.70	2.00	1.93	1.99	1.49	1.75	1.93	-1.30	82.35	1	17
Other personal services workers	516	2.66	2.45	2.57	2.02	2.44	2.34	1.75	1.76	0.90	24.00	4	25
Shop salespersons	522	2.17	1.37	1.58	2.07	1.95	2.07	1.75	1.41	-1.04	62.87	3	167
Cashiers and ticket clerks	523	1.48	0.58	1.17	1.54	1.21	1.08	1.25	1.22	-3.10	90.00	1	20
Other sales workers	524	1.89	1.35	1.07	2.44	1.67	2.17	1.75	1.48	-1.54	50.00	3	16
Child care workers and teachers' aides	531	1.28	0.87	1.71	1.79	1.59	1.23	1.75	1.17	-2.68	100.00	1	84

Personal care workers in health services	532	1.04	0.87	1.24	2.05	1.76	1.66	1.41	1.77	-2.23	91.40	1	93
Protective services workers	541	1.33	1.57	1.37	1.90	1.82	1.75	1.40	2.50	-0.87	26.56	1	64
Market gardeners and crop growers	611	1.68	1.21	1.55	1.90	2.16	1.17	1.75	1.32	-1.38	30.00	2	90
Animal producers	612	1.74	1.23	1.31	1.90	2.42	1.32	1.75	0.89	-1.37	30.77	2	26
Mixed crop and animal producers	613	2.15	1.29	1.51	2.16	2.69	1.59	1.75	1.11	-0.53	20.00	3	10
Building frame and related trades workers	711	1.77	1.16	1.62	2.01	1.51	1.42	1.75	1.22	-2.14	4.76	2	84
Building finishers and related trades workers	712	2.08	2.14	1.54	1.78	1.71	1.54	1.75	1.66	-0.66	0.00	3	32
Painters, building structure cleaners and related trades workers	713	1.64	1.10	1.25	1.83	1.28	1.29	1.50	0.63	-3.00	0.00	2	16
Sheet and structural metal workers, moulders and welders, and related workers	721	1.52	1.06	0.99	1.80	1.14	1.30	1.75	1.22	-2.81	0.00	1	25
Blacksmiths, toolmakers and related trades workers	722	1.75	1.14	1.61	1.80	1.34	1.03	1.34	1.31	-2.28	12.90	2	31
Machinery mechanics and repairers	723	1.70	1.21	1.64	2.30	2.27	1.95	1.75	1.93	-0.77	2.86	2	35
Handicraft workers	731	1.55	1.72	2.06	1.85	1.86	1.97	1.75	1.77	-1.12	46.67	1	15
Printing trades workers	732	2.06	1.53	1.52	2.05	1.56	1.14	1.75	1.87	-1.10	23.08	3	13
Electrical equipment installers and repairers	741	1.90	1.30	1.71	2.37	2.07	1.75	1.75	2.02	-0.70	0.00	3	33
Food processing and related trades workers	751	1.61	0.98	1.47	1.69	1.37	1.75	1.77	1.22	-2.54	15.00	2	40
Other craft and related workers	754	2.37	1.77	1.96	1.61	1.92	1.97	1.75	2.28	0.03	28.57	4	14
Metal processing and finishing plant operators	812	1.89	0.74	1.18	1.40	1.41	0.68	1.01	1.93	-1.88	11.76	3	17
Textile, fur and leather products machine operators	815	1.90	1.23	1.39	1.82	0.89	0.73	1.28	1.22	-2.67	64.29	3	14
Food and related products machine operators	816	1.48	1.15	1.10	1.77	1.27	0.79	1.25	1.67	-2.29	48.15	1	27
Other stationary plant and machine operators	818	1.20	0.98	1.39	1.81	1.09	0.95	1.28	1.22	-3.18	36.17	1	47
Assemblers	821	1.64	0.86	1.20	1.66	1.21	0.89	1.32	1.00	-2.94	28.21	2	39
Car, van and motorcycle drivers	832	1.10	1.02	1.31	1.61	1.33	1.48	1.75	1.23	-2.96	10.20	1	49
Heavy truck and bus drivers	833	1.40	1.45	1.39	1.90	1.56	1.08	1.32	1.55	-1.93	6.56	1	61
Mobile plant operators	834	1.25	0.98	1.28	1.80	1.13	0.91	1.75	1.22	-3.09	2.50	1	40
Domestic, hotel and office cleaners and helpers	911	0.83	0.98	1.70	1.58	0.81	1.07	1.56	1.00	-3.94	86.16	1	224
Mining and construction labourers	931	1.06	0.95	1.18	2.05	1.35	1.33	0.94	1.22	-3.03	11.11	1	18
Transport and storage labourers	933	1.48	1.38	1.47	1.82	1.56	1.36	1.71	1.90	-1.63	28.99	1	69
Food preparation assistants	941	1.55	0.99	1.06	1.59	1.19	1.54	1.20	0.95	-3.00	54.17	1	24
Other elementary workers	962	0.97	1.10	0.97	2.01	1.54	1.37	1.21	1.14	-2.85	87.10	1	31

FRANCE	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Non-commissioned armed forces officers	21	2.97	2.46	2.34	1.86	2.75	2.08	1.40	2.55	2.64	10.00	4	20
Teaching professionals	23	1.68	1.88	1.98	2.03	2.76	2.76	1.76	1.95	0.48	92.00	2	25
Information and communications technology professionals	25	2.20	2.53	2.39	2.12	2.57	1.74	1.25	2.29	1.61	0.00	3	10
Personal service workers	51	2.07	0.92	2.42	1.87	2.00	2.09	1.24	1.28	-1.19	54.55	3	11
Stationary plant and machine operators	81	1.25	0.87	1.19	2.00	0.78	1.66	1.40	1.90	-2.48	45.45	1	11
Legislators and senior officials	111	2.31	2.30	2.16	1.57	2.96	2.26	1.39	2.43	1.99	25.00	3	12
Business services and administration managers	121	2.91	2.62	3.01	1.49	2.91	2.29	1.25	2.25	2.59	36.36	4	11
Manufacturing, mining, construction, and distribution managers	132	3.22	2.62	2.74	1.89	2.70	2.55	1.56	2.52	2.92	8.33	4	60
Professional services managers	134	2.51	2.38	2.59	1.92	2.88	2.79	1.56	2.60	2.32	50.00	4	40
Engineering professionals (excluding electrotechnology)	214	3.24	2.51	2.05	2.00	2.57	2.14	1.40	2.40	2.63	19.30	4	57
Electrotechnology engineers	215	2.40	2.54	2.03	1.90	2.38	1.83	1.43	2.24	1.59	20.00	4	10
Architects, planners, surveyors and designers	216	2.38	2.27	2.42	1.98	2.77	1.94	1.47	2.11	1.58	35.29	4	34
Medical doctors	221	2.03	1.66	1.85	1.89	3.08	2.55	1.69	3.55	2.37	53.85	3	26
Other health professionals	226	2.37	1.56	2.06	2.11	2.68	2.18	1.45	2.23	1.04	75.86	4	29
Secondary education teachers	233	1.68	1.71	1.87	1.95	2.90	2.83	1.81	1.82	0.36	62.90	2	62
Primary school and early childhood teachers	234	1.55	1.34	1.75	2.36	2.46	2.79	1.81	2.04	-0.24	100.00	2	17
Other teaching professionals	235	2.10	2.00	2.16	2.03	2.77	2.53	1.31	2.13	1.13	58.97	3	39
Finance professionals	241	3.21	2.57	2.24	2.11	2.76	1.89	1.44	2.34	2.76	40.63	4	64
Administration professionals	242	2.52	2.56	2.46	1.99	2.70	2.39	1.50	2.45	2.18	44.83	4	29
Sales, marketing and public relations professionals	243	2.52	2.33	2.44	1.96	2.67	2.17	1.44	2.23	1.77	60.47	4	43
Software and applications developers and analysts	251	2.37	2.41	2.30	2.00	2.65	2.01	1.35	2.23	1.68	17.14	4	35
Database and network professionals	252	2.20	2.56	2.00	2.36	2.93	1.88	1.40	2.25	1.92	0.00	3	11
Legal professionals	261	2.21	2.09	2.94	2.00	3.06	2.40	1.40	2.78	2.15	29.41	3	17
Social and religious professionals	263	1.51	1.97	2.16	1.81	2.63	2.24	1.59	2.58	0.87	67.16	1	67
Authors, journalists and linguists	264	1.77	2.62	2.13	1.79	2.49	1.51	1.50	2.31	1.23	40.00	2	15
Creative and performing artists	265	1.29	1.29	2.08	2.18	2.24	1.29	1.18	1.79	-0.93	38.46	1	13
Physical and engineering science technicians	311	2.44	2.15	1.98	1.99	2.43	1.75	1.33	2.11	1.24	25.42	4	59
Mining, manufacturing and construction supervisors	312	2.34	1.75	1.97	1.61	2.23	2.79	3.25	2.46	0.98	0.00	4	10

Medical and pharmaceutical technicians	321	1.91	1.20	1.94	1.81	2.40	1.75	1.56	1.03	-0.99	84.21	3	19
Nursing and midwifery associate professionals	322	1.17	1.26	1.83	2.12	2.26	1.94	1.40	3.17	0.21	86.61	1	112
Other health associate professionals	325	1.49	1.33	1.83	1.75	2.18	1.95	1.27	2.40	-0.22	88.17	1	93
Financial and mathematical associate professionals	331	2.92	2.25	2.24	1.94	2.59	1.82	1.22	2.00	1.79	65.45	4	55
Sales and purchasing agents and brokers	332	2.66	2.31	2.57	1.86	2.64	2.27	1.45	2.31	1.93	31.46	4	89
Business services agents	333	2.22	2.60	2.68	1.76	2.59	2.20	1.40	2.24	1.65	50.00	3	30
Administrative and specialised secretaries	334	2.36	2.12	2.30	2.00	2.64	2.11	1.25	2.14	1.35	73.33	4	15
Regulatory government associate professionals	335	1.79	2.08	1.93	1.89	2.50	1.86	1.11	2.25	0.78	67.44	2	86
Legal, social and religious associate professionals	341	1.46	1.85	2.00	1.76	2.29	1.96	1.31	2.11	0.00	76.47	1	34
Information and communications technology operations and user support technicians	351	2.04	2.38	2.53	2.35	2.74	2.03	1.40	2.35	1.55	11.11	3	18
General office clerks	411	2.32	2.37	2.17	1.83	2.31	1.87	1.29	2.00	1.09	79.51	4	122
Secretaries (general)	412	2.05	2.14	2.00	1.75	2.22	1.60	1.05	2.14	0.72	94.29	3	35
Tellers, money collectors and related clerks	421	2.26	1.31	2.47	1.57	2.18	1.32	1.10	2.00	0.09	60.00	3	10
Client information workers	422	2.01	2.09	1.85	1.99	2.37	2.07	0.92	2.26	0.89	79.41	3	34
Numerical clerks	431	2.42	2.15	2.22	1.75	2.43	1.80	1.37	2.04	1.16	76.62	4	77
Material-recording and transport clerks	432	2.25	1.92	2.00	1.75	2.29	1.76	1.00	2.08	0.73	34.04	3	94
Other clerical support workers	441	1.30	2.02	1.53	1.57	1.78	1.31	1.04	1.78	-0.76	52.94	1	34
Cooks	512	2.08	1.71	2.17	1.70	2.34	1.93	1.81	1.81	0.22	43.48	3	23
Waiters and bartenders	513	1.53	1.14	1.49	1.56	1.58	1.72	1.08	1.04	-2.10	62.07	2	29
Hairdressers, beauticians and related workers	514	1.81	1.33	2.30	1.69	2.01	1.92	1.40	1.38	-1.01	89.29	2	28
Building and housekeeping supervisors	515	1.56	1.42	2.24	1.57	1.66	1.44	1.45	1.79	-1.09	28.33	2	60
Shop salespersons	522	1.93	1.50	1.93	1.86	2.05	2.13	1.31	1.67	-0.47	77.16	3	197
Cashiers and ticket clerks	523	1.25	0.70	1.71	1.62	1.54	1.72	1.10	1.17	-2.61	94.44	1	18
Other sales workers	524	2.47	2.07	2.22	1.96	2.11	1.92	1.29	2.00	0.82	60.00	4	15
Child care workers and teachers' aides	531	1.10	1.29	2.02	1.96	2.25	1.97	1.35	2.01	-0.90	95.00	1	60
Personal care workers in health services	532	1.39	1.17	1.73	1.92	1.97	1.40	1.17	2.30	-0.71	82.00	1	50
Protective services workers	541	1.25	1.79	1.79	2.03	2.41	1.70	1.10	3.04	0.71	13.95	1	43
Market gardeners and crop growers	611	1.95	1.30	2.24	1.50	2.28	1.60	1.56	1.50	-0.56	35.48	3	31
Animal producers	612	1.85	1.12	2.11	1.42	2.66	1.51	0.80	1.57	-0.39	33.33	2	12

Mixed crop and animal producers	613	2.17	1.26	2.67	1.78	2.43	1.27	1.64	1.57	-0.20	0.00	3	13
Building frame and related trades workers	711	1.53	1.44	1.81	1.56	1.47	1.64	1.40	1.59	-1.46	1.82	2	55
Building finishers and related trades workers	712	1.68	1.93	1.98	1.70	1.76	1.61	1.40	1.70	-0.58	2.94	2	68
Painters, building structure cleaners and related trades workers	713	1.62	1.39	1.88	1.60	1.74	1.65	1.40	2.11	-0.70	8.00	2	25
Sheet and structural metal workers, moulders and welders, and related workers	721	1.64	1.26	1.78	1.42	1.17	1.27	1.76	1.15	-2.16	0.00	2	23
Blacksmiths, toolmakers and related trades workers	722	1.38	1.45	2.00	1.86	2.31	1.67	1.81	2.04	-0.44	0.00	1	15
Machinery mechanics and repairers	723	1.86	1.12	1.88	1.80	1.92	1.51	1.50	2.00	-0.65	2.86	3	105
Printing trades workers	732	1.69	2.09	2.27	1.85	2.31	1.69	1.30	1.74	0.06	16.67	2	18
Electrical equipment installers and repairers	741	1.80	1.59	2.24	1.78	2.11	1.79	1.40	2.28	0.09	0.00	2	33
Electronics and telecommunications installers and repairers	742	1.67	1.73	2.21	1.52	2.16	1.55	1.35	2.37	0.21	10.00	2	20
Food processing and related trades workers	751	1.85	1.27	1.95	1.45	2.06	2.00	1.08	1.90	-0.49	28.57	3	14
Wood treaters, cabinet-makers and related trades workers	752	1.56	1.63	1.64	1.80	1.46	1.32	1.23	1.56	-1.31	0.00	2	15
Garment and related trades workers	753	1.81	1.52	4.42	1.89	2.11	1.77	1.48	1.38	-0.78	40.00	2	15
Other craft and related workers	754	1.93	1.63	1.91	1.75	1.95	1.48	1.40	2.35	0.16	34.48	3	29
Metal processing and finishing plant operators	812	1.40	0.69	1.36	1.57	1.43	1.19	1.21	1.03	-2.71	5.13	1	39
Chemical and photographic products plant and machine operators	813	1.83	1.36	1.41	1.35	1.66	1.45	0.90	1.52	-1.14	6.25	2	16
Rubber, plastic and paper products machine operators	814	1.42	1.27	1.47	2.16	1.51	1.54	1.25	1.54	-1.70	14.29	1	14
Textile, fur and leather products machine operators	815	1.83	0.77	1.38	1.64	1.16	1.27	1.21	1.03	-2.50	71.43	2	14
Food and related products machine operators	816	2.15	1.06	2.00	1.29	1.25	1.04	1.40	1.89	-1.12	28.57	3	14
Other stationary plant and machine operators	818	1.14	1.03	1.31	2.05	1.21	0.86	1.30	1.24	-2.67	42.86	1	14
Assemblers	821	1.26	1.04	1.33	1.56	1.50	1.13	1.02	1.03	-2.50	25.00	1	36
Car, van and motorcycle drivers	832	1.09	3.93	1.56	1.63	1.24	0.91	0.80	1.03	-0.62	25.00	1	12
Heavy truck and bus drivers	833	1.45	1.55	1.72	1.57	1.63	1.12	1.19	2.00	-0.93	0.00	1	57
Mobile plant operators	834	1.25	1.03	1.54	1.64	1.17	1.36	1.45	1.24	-2.62	3.33	1	30
Domestic, hotel and office cleaners and helpers	911	1.59	1.32	2.01	1.05	0.41	1.04	0.80	0.92	-3.04	95.77	2	71
Manufacturing labourers	932	1.36	0.68	1.23	1.11	0.41	0.79	0.89	1.03	-3.65	30.43	1	23
Transport and storage labourers	933	1.25	1.23	1.47	1.49	1.40	1.27	1.07	1.36	-2.14	31.58	1	38
Food preparation assistants	941	1.26	0.06	1.73	1.72	0.75	1.11	0.80	0.90	-4.06	85.71	1	21
Other elementary workers	962	1.60	0.70	2.32	1.02	0.91	1.22	0.80	1.17	-2.85	46.15	2	26

IRELAND	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Armed forces occupations, other ranks	3	2.11	1.62	1.17	1.83	2.58	2.03	1.47	2.33	0.49	9.09	3	11
Administrative and commercial managers	12	2.69	3.26	2.22	2.01	2.77	2.97	3.01	2.70	2.56	51.11	4	45
Production and specialised services managers	13	2.47	2.45	2.22	2.17	2.65	3.07	3.73	2.53	1.58	31.58	4	95
Hospitality, retail and other services managers	14	2.29	2.01	1.80	1.93	2.36	2.92	3.73	2.38	0.69	37.50	4	128
Non-commissioned armed forces officers	21	2.76	2.53	1.78	1.94	2.63	2.33	2.41	2.63	1.91	25.71	4	105
Health professionals	22	1.80	1.31	1.47	2.57	2.49	2.65	3.01	2.99	0.44	78.71	2	202
Teaching professionals	23	1.87	1.58	1.54	2.18	2.72	3.37	3.73	2.17	0.30	70.44	2	203
Business and administration professionals	24	2.70	2.92	1.96	2.05	2.50	2.57	2.41	2.71	2.06	49.22	4	193
Information and communications technology professionals	25	2.35	2.99	2.22	2.30	2.51	2.33	3.01	2.41	1.60	25.76	4	66
Legal, social and cultural professionals	26	1.63	1.99	2.11	1.90	2.37	2.37	2.05	2.38	0.15	56.32	1	87
Armed forces occupations, other ranks	31	2.55	1.88	1.62	1.85	2.28	1.93	1.75	2.62	0.91	25.81	4	62
Health associate professionals	32	1.70	1.38	1.35	2.27	2.26	2.16	1.75	2.41	-0.29	66.67	2	24
Business and administration associate professionals	33	2.35	2.62	1.80	1.96	2.23	2.39	2.41	2.56	1.16	62.44	4	197
Legal, social, cultural and related associate professionals	34	1.87	1.80	1.71	2.05	2.08	2.35	3.01	2.01	-0.37	52.50	2	80
Information and communications technicians	35	2.23	3.12	1.55	2.30	2.47	2.17	1.86	2.15	1.35	26.67	3	15
General and keyboard clerks	41	2.04	2.30	1.64	1.72	2.09	1.90	1.75	2.07	0.16	100.00	3	56
Customer services clerks	42	2.29	2.07	1.23	2.26	2.15	2.15	1.75	2.23	0.39	74.55	3	110
Numerical and material recording clerks	43	2.46	2.30	1.69	1.75	2.03	1.91	1.75	2.21	0.54	63.73	4	102
Other clerical support workers	44	2.08	2.02	1.61	1.66	1.93	1.77	1.75	2.05	-0.21	82.79	3	122
Personal service workers	51	1.55	1.02	1.51	1.56	1.52	1.85	1.75	1.19	-2.42	69.60	1	125
Sales workers	52	1.98	1.21	1.47	1.96	1.70	2.08	1.75	1.42	-1.57	69.23	2	234
Personal care workers	53	1.31	1.15	1.15	1.90	1.80	2.15	1.75	2.01	-1.58	91.79	1	207
Protective services workers	54	0.96	1.39	1.47	1.94	2.14	2.17	1.75	2.73	-0.76	16.36	1	55
Market-oriented skilled agricultural workers	61	1.68	1.09	1.95	1.78	2.05	1.28	1.75	0.83	-1.97	11.11	1	135
Building and related trades workers, excluding electricians	71	1.93	1.16	1.80	1.72	1.68	1.82	1.75	1.16	-1.87	2.06	2	97
Metal, machinery and related trades workers	72	2.00	1.35	1.50	1.90	1.90	1.96	1.75	2.24	-0.60	4.82	3	83
Handicraft and printing workers	73	1.92	1.22	1.39	2.01	1.83	1.97	1.75	2.20	-0.87	29.41	2	17
Electrical and electronic trades workers	74	2.23	1.89	1.63	2.04	2.25	2.18	1.75	2.48	0.52	8.33	3	48

Food processing, wood working, garment and other craft and related trades workers	75	2.03	1.44	1.38	1.53	1.76	2.10	1.75	1.85	-0.98	42.86	3	63
Stationary plant and machine operators	81	2.11	1.21	1.20	1.84	1.59	1.52	1.75	1.50	-1.53	42.59	3	54
Assemblers	82	1.95	1.52	1.51	2.03	1.74	1.49	1.75	1.06	-1.62	12.50	2	16
Drivers and mobile plant operators	83	1.70	1.09	1.35	1.55	1.64	1.55	1.75	1.38	-1.97	5.83	2	103
Cleaners and helpers	91	0.68	1.21	1.17	1.18	1.04	1.10	1.66	0.87	-3.77	67.14	1	70
Labourers in mining, construction, manufacturing and transport	93	1.48	1.39	1.38	1.94	1.67	1.92	1.75	1.72	-1.65	11.11	1	72
Food preparation assistants	94	1.20	0.73	1.04	1.61	0.95	1.39	1.32	1.00	-3.67	67.50	1	40
Refuse workers and other elementary workers	96	1.62	1.26	1.39	1.94	1.68	1.65	1.75	1.72	-1.62	20.41	1	49
ITALY	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Building and related trades workers, excluding electricians	71	1.61	1.57	1.51	1.94	1.04	1.55	1.70	1.08	-2.62	0.00	2	10
Manufacturing, mining, construction, and distribution managers	132	2.48	2.06	2.40	2.05	2.27	2.37	3.01	1.82	0.34	9.52	4	21
Professional services managers	134	2.63	2.44	2.26	2.16	3.18	3.06	3.73	2.86	2.53	20.00	4	10
Hotel and restaurant managers	141	1.55	1.75	2.40	1.44	2.02	2.15	3.73	0.83	-1.66	53.33	2	15
Other services managers	143	1.76	2.21	2.06	1.53	2.90	2.68	1.71	2.58	1.15	40.00	3	10
Non-commissioned armed forces officers	210	1.60	1.92	1.31	2.27	2.23	2.36	3.73	2.73	0.21	0.00	2	11
Engineering professionals (excluding electrotechnology)	214	3.62	3.02	2.13	2.40	2.59	2.10	2.71	2.63	2.90	10.00	4	20
Architects, planners, surveyors and designers	216	2.41	2.21	2.09	2.20	2.50	1.92	1.75	2.21	0.94	34.78	4	23
Medical doctors	221	2.02	2.18	1.78	1.96	2.75	2.45	2.58	2.39	1.04	25.00	3	32
Other health professionals	226	1.95	1.66	2.01	2.16	2.72	2.06	1.86	1.93	0.22	59.26	3	27
University and higher education teachers	231	1.86	2.40	2.35	2.71	2.70	2.13	1.77	2.61	1.17	57.14	3	14
Secondary education teachers	233	1.55	1.40	1.46	1.93	2.54	2.86	1.75	2.01	-0.40	68.66	2	67
Primary school and early childhood teachers	234	1.20	1.11	1.38	2.17	1.97	1.90	1.75	1.65	-1.78	100.00	1	51
Other teaching professionals	235	1.61	1.83	1.95	2.01	2.21	2.01	1.62	1.81	-0.57	85.71	2	14
Finance professionals	241	2.79	3.17	2.14	2.09	3.07	2.50	3.01	2.20	2.53	42.86	4	28
Administration professionals	242	2.87	2.93	1.88	1.91	2.79	2.67	3.01	2.44	2.31	42.11	4	19
Sales, marketing and public relations professionals	243	2.83	2.96	2.31	1.62	2.66	2.29	1.75	2.38	2.10	20.69	4	29
Software and applications developers and analysts	251	3.39	2.82	2.13	1.83	2.48	2.09	1.75	2.21	2.13	13.33	4	15
Legal professionals	261	1.63	2.30	2.36	2.57	3.48	1.85	1.75	2.35	1.58	46.67	2	30
Authors, journalists and linguists	264	1.46	3.09	2.48	2.13	3.06	1.77	1.75	2.92	1.96	61.54	2	13

Physical and engineering science technicians	311	2.95	2.61	2.03	2.05	2.46	1.90	1.75	2.48	1.82	10.34	4	58
Mining, manufacturing and construction supervisors	312	2.37	2.60	2.13	1.83	1.94	2.74	3.73	2.14	0.51	17.65	4	34
Medical and pharmaceutical technicians	321	1.81	1.75	1.69	1.73	2.17	1.75	1.75	1.37	-0.86	33.33	3	12
Nursing and midwifery associate professionals	322	1.62	0.90	1.38	2.17	1.72	1.91	1.75	1.80	-1.75	73.68	2	38
Other health associate professionals	325	2.03	2.24	1.86	1.96	2.41	1.72	1.87	2.38	0.70	45.00	3	20
Financial and mathematical associate professionals	331	2.49	2.62	1.87	2.01	2.29	2.09	1.75	2.23	1.08	67.86	4	84
Sales and purchasing agents and brokers	332	2.37	2.62	1.91	1.72	2.26	2.38	1.75	2.06	0.82	24.59	4	61
Business services agents	333	2.46	2.62	2.31	2.11	2.32	2.29	1.75	2.23	1.09	51.43	4	35
Administrative and specialised secretaries	334	2.14	2.10	1.66	2.01	2.04	1.60	1.75	2.21	0.14	73.68	3	76
Regulatory government associate professionals	335	1.48	1.92	1.25	1.72	1.98	1.73	1.75	2.64	-0.23	35.71	2	14
Legal, social and religious associate professionals	341	1.66	1.76	1.51	2.25	2.10	2.23	1.86	2.62	-0.08	85.00	2	20
Artistic, cultural and culinary associate professionals	343	1.90	2.06	1.59	2.26	2.40	1.81	1.75	1.41	-0.29	30.00	3	10
Information and communications technology operations and user support technicians	351	1.82	2.62	1.75	1.90	2.45	1.81	1.75	2.21	0.70	26.09	3	23
General office clerks	411	2.16	2.31	1.54	1.85	1.88	1.59	1.75	2.00	-0.02	75.61	3	41
Secretaries (general)	412	1.34	1.92	1.27	1.93	1.69	1.51	1.75	1.92	-1.23	90.91	1	11
Keyboard operators	413	1.84	1.68	1.72	2.11	2.08	0.96	1.75	1.58	-0.82	91.67	3	12
Tellers, money collectors and related clerks	421	2.37	1.89	1.39	1.90	2.16	2.16	1.75	1.93	0.10	75.86	4	29
Client information workers	422	2.24	1.93	1.54	1.69	1.92	1.89	1.75	1.74	-0.38	63.16	4	57
Numerical clerks	431	2.37	2.30	1.71	2.05	2.13	1.42	1.75	1.91	0.33	69.35	4	62
Material-recording and transport clerks	432	2.26	2.31	1.69	1.57	1.71	1.50	2.05	1.93	-0.20	61.76	4	34
Other clerical support workers	441	1.56	2.02	1.38	1.70	1.72	1.47	1.75	1.75	-1.08	58.06	2	31
Cooks	512	1.89	1.54	1.54	2.13	1.92	1.62	1.77	1.17	-1.38	38.89	3	18
Waiters and bartenders	513	1.40	1.41	1.54	1.72	0.92	1.50	1.75	1.11	-2.99	59.18	1	49
Hairdressers, beauticians and related workers	514	1.48	1.29	2.40	2.26	2.20	2.08	3.01	0.90	-1.77	86.96	2	23
Building and housekeeping supervisors	515	1.43	1.59	1.47	1.83	1.13	1.65	1.70	0.76	-2.89	50.00	1	10
Shop salespersons	522	1.97	1.57	1.54	1.80	1.68	2.03	1.75	1.22	-1.51	55.31	3	179
Cashiers and ticket clerks	523	2.03	1.10	0.89	0.93	0.30	0.98	0.82	1.00	-3.47	83.33	3	12
Other sales workers	524	1.53	1.02	1.62	1.74	1.41	1.67	1.58	1.03	-2.68	50.00	2	22
Personal care workers in health services	532	0.96	0.95	1.78	1.64	0.90	1.59	1.75	0.89	-3.86	86.59	1	82

Protective services workers	541	1.08	1.72	1.30	1.90	1.88	1.54	1.60	2.19	-1.15	14.29	1	28
Market gardeners and crop growers	611	1.18	2.24	2.40	2.30	1.59	1.43	1.75	0.47	-2.37	16.00	1	25
Animal producers	612	0.96	1.53	2.40	1.29	0.67	0.98	1.75	1.47	-3.27	8.33	1	12
Building frame and related trades workers	711	1.50	1.72	1.40	2.16	1.03	1.36	1.75	0.88	-2.76	0.00	2	47
Building finishers and related trades workers	712	1.92	1.59	1.63	2.02	1.69	1.60	1.75	1.55	-1.27	0.00	3	40
Painters, building structure cleaners and related trades workers	713	1.70	0.25	2.06	1.73	0.71	1.39	1.75	1.11	-3.77	0.00	3	14
Sheet and structural metal workers, moulders and welders, and related workers	721	1.43	1.02	1.51	1.47	1.13	1.28	1.41	1.17	-2.96	0.00	1	22
Blacksmiths, toolmakers and related trades workers	722	1.58	1.30	1.55	2.27	1.15	1.41	1.75	0.95	-2.80	0.00	2	27
Machinery mechanics and repairers	723	1.69	1.17	1.62	1.94	1.50	1.42	1.75	1.57	-1.94	3.70	3	27
Handicraft workers	731	2.36	1.65	1.39	1.98	2.33	2.06	3.01	1.00	-0.60	27.27	4	11
Electrical equipment installers and repairers	741	1.36	1.64	1.88	2.09	1.95	1.48	1.50	1.90	-1.12	0.00	1	24
Food processing and related trades workers	751	2.19	1.14	1.55	1.96	1.08	1.75	1.75	1.00	-2.46	29.17	4	24
Wood treaters, cabinet-makers and related trades workers	752	1.74	1.32	1.39	1.77	1.26	1.25	1.75	1.00	-2.49	9.09	3	22
Other craft and related workers	754	1.74	1.85	1.58	1.66	2.11	1.99	3.73	2.72	0.13	18.75	3	16
Rubber, plastic and paper products machine operators	814	1.51	1.20	0.76	1.45	0.70	0.79	1.58	1.03	-3.36	26.67	2	15
Textile, fur and leather products machine operators	815	1.66	2.01	1.53	1.58	1.19	1.25	1.75	1.67	-1.65	60.00	2	30
Other stationary plant and machine operators	818	1.45	1.09	0.97	1.77	0.93	0.75	1.75	1.41	-2.93	41.67	2	12
Assemblers	821	1.38	1.05	1.07	1.56	1.07	0.98	1.65	1.00	-3.18	39.47	1	38
Car, van and motorcycle drivers	832	0.89	1.15	0.85	1.07	1.28	0.79	0.92	1.00	-3.27	18.18	1	11
Heavy truck and bus drivers	833	1.34	1.21	1.30	1.35	1.25	1.15	1.75	1.00	-2.90	2.27	1	44
Mobile plant operators	834	1.20	0.95	1.39	1.74	0.93	0.99	1.75	0.95	-3.58	5.00	1	20
Domestic, hotel and office cleaners and helpers	911	0.78		1.32	1.27	0.51	0.79	1.65	0.63		76.40	1	89
Agricultural, forestry and fishery labourers	921	0.46		1.40	1.72	0.37	0.79	1.37	0.47		50.00	1	46
Mining and construction labourers	931	0.78	1.89	1.32	2.09	0.90	1.22	1.25	1.86	-2.61	0.00	1	16
Manufacturing labourers	932	1.20	1.18	1.28	2.42	0.26	0.79	1.75	1.00	-4.12	40.00	1	10
Transport and storage labourers	933	1.56	1.55	1.39	1.69	1.34	1.38	1.75	1.11	-2.31	12.50	2	40
JAPAN	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Managing directors and chief executives	112	2.29	2.02	3.73	1.96	2.81	2.67	1.75	2.23	1.09	11.76	4	17
Business services and administration managers	121	2.10	2.31	2.59	1.74	2.81	2.44	1.50	2.56	1.39	7.69	4	52

Sales, marketing and development managers	122	2.79	2.34	3.22	2.03	3.14	2.69	1.65	2.82	2.51	4.55	4	66
Manufacturing, mining, construction, and distribution managers	132	2.72	2.38	2.79	2.03	2.65	2.60	1.70	2.56	1.74	0.00	4	33
Information and communications technology service managers	133	2.42	2.57	2.50	1.78	3.02	2.65	1.58	2.86	2.27	0.00	4	12
Professional services managers	134	2.06	2.08	2.50	2.08	3.24	2.81	1.65	2.99	2.00	16.67	4	54
Engineering professionals (excluding electrotechnology)	214	3.39	2.03	2.66	1.72	2.85	1.83	1.56	2.71	2.38	6.25	4	16
Architects, planners, surveyors and designers	216	2.53	1.87	2.71	2.09	2.70	2.16	1.56	2.23	1.05	17.65	4	34
Nursing and midwifery professionals	222	1.43	0.92	1.95	1.84	2.26	1.92	1.60	2.37	-0.86	98.57	2	70
Other health professionals	226	2.12	1.44	2.22	2.01	2.37	1.95	1.32	2.43	0.22	78.57	4	56
University and higher education teachers	231	2.39	2.85	2.80	1.31	3.75	2.46	1.41	3.29	3.59	40.00	4	15
Secondary education teachers	233	1.84	1.36	2.00	1.93	2.75	2.89	1.63	2.42	0.35	38.10	3	42
Primary school and early childhood teachers	234	1.90	1.33	2.09	2.26	2.71	2.55	1.75	2.72	0.57	71.88	3	32
Other teaching professionals	235	1.55	1.30	2.50	1.83	2.27	1.77	1.49	1.87	-0.88	70.31	2	64
Finance professionals	241	2.32	1.92	2.49	2.13	3.12	1.86	1.41	2.74	1.77	13.33	4	15
Administration professionals	242	2.20	2.31	3.15	2.01	2.70	2.12	1.51	2.68	1.43	16.67	4	18
Sales, marketing and public relations professionals	243	2.14	2.21	2.40	2.09	2.68	2.19	1.41	2.73	1.34	20.00	4	40
Software and applications developers and analysts	251	2.25	2.62	2.40	2.05	2.61	1.95	1.43	2.52	1.46	14.00	4	50
Social and religious professionals	263	1.32	1.00	2.13	2.13	2.13	2.11	1.32	2.52	-0.91	70.59	1	34
Authors, journalists and linguists	264	1.65	1.89	2.56	1.58	3.05	1.65	1.41	2.45	0.91	41.67	2	12
Physical and engineering science technicians	311	2.96	2.02	2.40	1.97	2.53	1.80	1.43	2.29	1.37	16.30	4	92
Mining, manufacturing and construction supervisors	312	2.73	1.77	2.71	1.85	2.43	2.34	1.65	2.56	1.09	0.00	4	55
Medical and pharmaceutical technicians	321	1.40	1.02	2.13	1.83	2.45	1.27	1.23	1.52	-1.27	43.75	1	16
Nursing and midwifery associate professionals	322	1.20	0.63	1.87	1.64	1.87	1.43	1.45	2.53	-1.54	90.91	1	11
Other health associate professionals	325	1.48	0.97	2.13	1.90	2.24	1.75	1.39	2.33	-0.84	75.41	2	61
Financial and mathematical associate professionals	331	2.51	2.32	2.65	1.64	2.45	1.68	1.32	2.70	1.43	57.14	4	14
Sales and purchasing agents and brokers	332	1.96	1.75	2.82	2.01	2.48	2.18	1.65	2.56	0.52	23.30	3	103
Business services agents	333	1.73	2.08	2.71	1.77	2.48	1.92	1.48	2.23	0.31	33.33	3	48
Administrative and specialised secretaries	334	1.97	2.26	2.40	1.94	2.41	2.10	1.55	2.59	0.83	27.42	3	62
Regulatory government associate professionals	335	2.05	1.69	2.13	2.05	2.85	2.05	1.52	2.48	0.90	23.53	4	17
Sports and fitness workers	342	1.65	1.36	2.22	2.30	2.24	2.00	1.75	1.87	-0.79	27.27	2	11

Artistic, cultural and culinary associate professionals	343	1.78	1.79	3.23	2.01	2.44	1.57	1.50	1.86	-0.19	21.43	3	14
Information and communications technology operations and user support technicians	351	1.73	2.32	2.60	1.75	2.36	1.59	1.41	2.38	0.46	37.04	3	27
General office clerks	411	1.76	1.72	2.40	1.64	2.10	1.36	1.34	2.17	-0.37	76.66	3	287
Keyboard operators	413	1.20	1.36	1.80	1.25	1.29	1.39	0.82	1.32	-2.62	100.00	1	10
Tellers, money collectors and related clerks	421	1.65	1.16	1.83	1.74	2.26	1.84	1.31	2.33	-0.54	78.57	2	28
Client information workers	422	1.55	1.21	1.89	1.90	2.00	1.51	1.05	2.23	-0.96	76.92	2	78
Numerical clerks	431	2.16	1.59	2.22	1.56	2.10	1.31	1.21	2.07	-0.23	76.19	4	63
Material-recording and transport clerks	432	1.70	1.74	2.40	1.61	2.02	1.47	1.21	2.21	-0.47	51.35	3	37
Other clerical support workers	441	1.20	0.90	1.80	1.53	1.75	1.41	1.26	1.93	-1.95	42.86	1	21
Cooks	512	1.55	1.09	2.13	1.79	1.81	1.50	1.32	1.68	-1.67	53.03	2	66
Waiters and bartenders	513	1.47	1.08	1.95	1.56	1.43	1.45	1.18	1.50	-2.30	79.07	2	43
Hairdressers, beauticians and related workers	514	1.55	1.30	2.71	2.17	2.26	1.77	1.41	1.93	-0.85	84.21	2	38
Building and housekeeping supervisors	515	1.38	1.53	2.23	1.76	2.03	1.79	1.50	2.38	-0.72	34.62	1	26
Other personal services workers	516	1.27	1.02	2.40	1.72	2.19	1.83	1.53	1.29	-1.83	68.75	1	16
Shop salespersons	522	1.55	1.06	2.40	1.93	1.82	1.62	1.41	1.93	-1.49	64.80	2	250
Cashiers and ticket clerks	523	1.30	0.79	1.11	1.93	1.52	1.41	1.36	1.36	-2.64	79.17	1	24
Other sales workers	524	1.58	1.56	2.31	2.05	2.13	1.81	1.48	2.17	-0.60	56.14	2	114
Child care workers and teachers' aides	531	0.96	0.85	2.13	2.02	2.28	1.93	1.32	2.41	-1.22	95.92	1	49
Personal care workers in health services	532	1.19	0.98	1.95	2.13	1.95	1.85	1.41	2.50	-1.25	77.78	1	144
Protective services workers	541	1.46	1.21	1.39	1.64	2.12	1.29	0.82	2.23	-0.90	5.56	2	36
Market gardeners and crop growers	611	1.39	1.01	2.50	1.61	1.96	1.47	1.70	1.23	-2.05	19.23	1	52
Building frame and related trades workers	711	1.81	1.08	2.40	1.76	1.78	1.14	1.39	1.70	-1.49	4.17	3	48
Building finishers and related trades workers	712	1.67	1.00	2.40	1.67	1.83	1.62	1.56	2.28	-1.16	5.41	2	37
Painters, building structure cleaners and related trades workers	713	1.50	0.87	2.31	1.90	1.50	1.60	1.05	1.48	-2.36	15.38	2	13
Sheet and structural metal workers, moulders and welders, and related workers	721	1.91	1.13	2.11	1.80	1.57	1.57	1.31	1.98	-1.39	9.68	3	31
Blacksmiths, toolmakers and related trades workers	722	2.01	0.79	2.05	1.69	1.39	1.77	1.41	1.67	-1.98	17.86	3	28
Machinery mechanics and repairers	723	1.82	0.93	2.23	1.88	2.33	1.87	1.75	2.23	-0.56	0.00	3	40
Handicraft workers	731	1.54	1.10	2.18	2.15	1.48	2.00	1.65	1.93	-1.84	50.00	2	18
Printing trades workers	732	1.67	1.72	1.87	1.79	1.83	1.53	1.61	2.13	-0.77	31.58	3	19

Electrical equipment installers and repairers	741	1.90	1.76	2.31	1.86	2.22	1.79	1.43	2.63	0.25	0.00	3	28
Electronics and telecommunications installers and repairers	742	1.61	1.25	2.93	1.72	2.12	1.64	1.58	2.44	-0.58	0.00	2	10
Food processing and related trades workers	751	1.49	0.98	2.22	1.64	1.57	1.33	1.26	1.74	-2.01	60.87	2	46
Garment and related trades workers	753	1.37	0.85	2.36	1.90	1.31	1.36	1.57	1.61	-2.58	83.33	1	12
Other craft and related workers	754	1.91	1.56	1.61	1.64	1.54	1.50	1.25	1.93	-1.17	38.98	3	59
Metal processing and finishing plant operators	812	1.77	0.91	1.97	1.54	1.66	1.57	1.37	2.23	-1.35	13.64	3	22
Chemical and photographic products plant and machine operators	813	1.71	1.31	1.72	1.45	1.93	1.62	1.07	2.41	-0.70	9.09	3	11
Rubber, plastic and paper products machine operators	814	1.20	0.82	2.51	2.01	1.18	1.30	1.53	1.50	-2.96	21.43	1	14
Food and related products machine operators	816	2.23	1.16	2.05	1.68	1.81	1.83	1.50	2.39	-0.53	36.36	4	11
Other stationary plant and machine operators	818	1.20	0.86	1.54	1.32	1.35	1.07	1.13	1.94	-2.42	57.69	1	26
Assemblers	821	1.67	1.15	1.75	1.47	1.45	1.44	1.44	1.74	-1.89	18.84	3	69
Car, van and motorcycle drivers	832	1.38	1.02	2.13	1.77	1.81	1.41	1.21	2.16	-1.48	8.70	1	46
Heavy truck and bus drivers	833	1.20	0.63	1.55	1.32	1.50	0.92	1.21	1.76	-2.55	2.56	1	39
Mobile plant operators	834	1.80	0.57	1.51	1.59	1.72	1.32	0.88	2.23	-1.49	0.00	3	14
Domestic, hotel and office cleaners and helpers	911	0.65	1.16	2.13	1.19	1.27	0.73	0.82	1.30	-3.24	78.13	1	32
Manufacturing labourers	932	1.44	1.06	1.25	1.41	1.32	0.91	0.94	1.43	-2.51	70.73	2	41
Transport and storage labourers	933	1.08	0.95	1.59	1.72	1.24	1.22	1.75	1.02	-3.29	48.28	1	29
Food preparation assistants	941	1.20	1.06	1.74	1.60	1.30	0.79	1.16	1.74	-2.49	89.66	1	29
Refuse workers	961	1.17	1.07	1.88	1.61	1.59	1.40	1.56	1.74	-2.19	8.33	1	12
Other elementary workers	962	1.20	0.81	1.82	1.52	1.76	1.30	1.04	1.40	-2.42	68.75	1	32
KOREA	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Business services and administration managers	121	2.20	2.47	2.40	0.89	2.68	2.45	1.65	2.13	1.09	24.00	4	25
Manufacturing, mining, construction, and distribution managers	132	2.24	2.29	2.21	1.64	2.49	2.37	1.65	2.35	0.97	0.00	4	31
Professional services managers	134	2.15	2.02	2.13	1.53	3.22	2.48	1.80	2.07	1.30	33.33	4	21
Retail and wholesale trade managers	142	2.14	1.81	4.30	1.58	2.98	2.47	3.01	2.37	1.10	10.53	3	19
Engineering professionals (excluding electrotechnology)	214	3.00	2.77	1.66	1.53	2.66	2.09	1.56	2.99	2.59	11.76	4	51
Electrotechnology engineers	215	2.50	2.62	1.58	1.74	2.66	2.31	1.75	2.62	1.79	5.00	4	40
Architects, planners, surveyors and designers	216	2.31	2.45	1.96	1.60	2.59	1.83	1.69	2.51	1.36	35.48	4	62
Nursing and midwifery professionals	222	1.88	1.41	1.38	1.53	2.36	2.10	1.59	2.73	0.23	96.97	3	33

Other health professionals	226	2.02	1.35	2.04	1.44	2.72	2.32	2.05	2.37	0.42	57.69	3	26
University and higher education teachers	231	1.95	2.16	2.06	0.84	3.35	2.45	1.75	2.23	1.50	38.10	3	21
Secondary education teachers	233	1.63	2.30	1.31	1.53	2.90	3.13	2.41	2.56	1.10	60.47	2	43
Primary school and early childhood teachers	234	1.81	2.30	1.47	1.64	3.14	2.91	3.01	2.48	1.45	80.00	3	35
Other teaching professionals	235	1.76	1.27	2.01	1.61	2.50	2.40	1.75	2.05	-0.34	83.74	3	123
Administration professionals	242	1.68	2.32	2.40	1.89	2.85	2.35	1.78	2.99	1.42	8.33	2	12
Sales, marketing and public relations professionals	243	2.73	3.27	2.13	1.58	2.67	2.41	1.75	2.73	2.51	11.54	4	26
Software and applications developers and analysts	251	2.14	3.31	1.80	2.25	2.91	2.28	1.65	2.73	2.34	22.22	4	36
Social and religious professionals	263	1.73	2.07	1.65	1.55	2.56	2.47	2.58	2.85	0.87	58.97	2	39
Authors, journalists and linguists	264	1.36	2.55	2.50	1.53	3.44	1.95	1.75	3.91	2.69	57.14	1	14
Creative and performing artists	265	0.43	1.43	1.88	2.30	2.51	2.37	1.49	1.78	-1.50	90.00	1	10
Physical and engineering science technicians	311	2.45	1.98	1.62	1.92	2.37	1.94	1.32	2.36	0.80	43.48	4	23
Process control technicians	313	1.81	1.39	1.86	1.79	2.40	1.79	1.50	2.38	-0.07	14.29	3	21
Medical and pharmaceutical technicians	321	1.22	1.13	1.67	1.28	2.32	1.75	1.39	2.48	-0.73	70.00	1	10
Nursing and midwifery associate professionals	322	1.70	0.83	1.08	1.55	1.85	1.49	1.32	1.93	-1.49	93.75	2	32
Other health associate professionals	325	2.07	1.22	1.47	1.41	2.26	1.82	1.50	2.33	-0.17	36.00	3	25
Financial and mathematical associate professionals	331	2.52	2.61	1.98	1.80	2.60	2.23	1.71	2.55	1.68	38.46	4	26
Sales and purchasing agents and brokers	332	2.46	1.62	2.40	2.13	2.65	2.26	1.75	2.48	0.97	57.14	4	70
Business services agents	333	2.41	2.08	2.22	1.53	2.61	2.09	1.55	2.23	0.99	37.10	4	62
Regulatory government associate professionals	335	2.16	2.56	1.54	1.53	2.50	1.69	1.50	2.84	1.47	36.71	4	79
Legal, social and religious associate professionals	341	2.06	2.15	1.80	1.49	2.46	2.26	1.50	2.99	1.18	75.00	3	16
Sports and fitness workers	342	1.63	1.61	2.06	1.69	2.51	2.83	1.65	2.46	0.12	15.38	2	13
Artistic, cultural and culinary associate professionals	343	1.58	1.07	2.20	1.56	2.04	1.72	1.75	1.79	-1.33	52.24	2	67
General office clerks	411	2.30	2.62	1.54	1.47	2.53	2.11	1.58	2.88	1.69	43.08	4	65
Keyboard operators	413	1.95	1.60	1.54	1.46	1.92	1.12	1.37	2.16	-0.51	75.86	3	29
Tellers, money collectors and related clerks	421	2.30	2.08	1.03	1.74	2.58	1.70	1.43	2.56	1.13	58.82	4	17
Client information workers	422	2.00	2.10	1.39	1.93	2.35	1.95	1.43	2.73	0.79	66.67	3	54
Numerical clerks	431	2.50	2.56	1.58	1.44	2.27	1.78	1.49	2.73	1.41	78.52	4	135
Material-recording and transport clerks	432	2.42	2.62	1.70	1.53	2.31	2.21	1.65	2.73	1.43	15.54	4	148

Other clerical support workers	441	2.35	2.48	2.04	1.60	2.61	2.34	1.96	2.73	1.60	23.93	4	163
Cooks	512	1.40	0.85	1.54	1.05	1.37	1.42	1.48	1.22	-2.80	84.34	1	83
Waiters and bartenders	513	1.55	0.96	1.46	1.19	1.39	1.59	1.65	1.22	-2.58	74.49	1	98
Hairdressers, beauticians and related workers	514	1.55	1.09	1.65	1.50	2.25	1.78	1.70	1.55	-1.29	91.30	1	46
Building and housekeeping supervisors	515	1.31	1.01	2.31	1.14	1.77	1.53	1.33	1.67	-1.97	47.37	1	19
Other personal services workers	516	1.55	0.99	2.40	1.53	1.70	1.42	1.50	1.72	-1.83	39.53	1	43
Street and market salespersons	521	1.96	1.16	1.66	1.44	1.91	1.75	1.65	1.72	-1.16	65.73	3	248
Cashiers and ticket clerks	523	1.76	1.02	1.38	1.36	1.69	1.37	1.51	1.22	-2.05	67.92	3	53
Other sales workers	524	2.33	1.59	2.14	1.64	2.16	2.00	1.65	2.48	0.30	37.68	4	138
Child care workers and teachers' aides	531	1.27	1.46	1.78	1.49	2.38	2.05	1.56	3.23	0.18	95.31	1	64
Personal care workers in health services	532	0.73	0.78	1.32	1.53	1.42	1.43	1.40	2.25	-2.53	88.64	1	44
Protective services workers	541	1.63	2.43	1.54	1.35	2.16	1.90	1.37	2.68	0.45	5.08	2	59
Market gardeners and crop growers	611	1.05	0.83	2.40	1.24	1.66	1.19	1.32	1.11	-2.85	34.21	1	114
Building frame and related trades workers	711	1.96	1.02	1.54	1.15	1.65	1.53	1.75	1.34	-1.83	0.00	3	42
Building finishers and related trades workers	712	2.18	1.26	1.54	1.22	1.88	1.80	1.75	1.93	-0.79	11.63	4	43
Sheet and structural metal workers, moulders and welders, and related workers	721	1.58	1.04	1.11	1.58	1.68	1.46	1.40	1.36	-2.08	0.00	2	25
Blacksmiths, toolmakers and related trades workers	722	1.97	1.11	1.47	1.57	1.67	1.30	1.43	1.93	-1.29	14.63	3	41
Machinery mechanics and repairers	723	1.74	1.74	1.54	1.93	2.25	1.81	1.65	2.01	-0.34	3.03	3	66
Handicraft workers	731	1.98	1.53	2.48	0.98	2.14	1.66	1.75	1.67	-0.68	21.74	3	23
Printing trades workers	732	1.64	2.24	2.39	1.57	1.92	1.84	1.75	2.02	-0.43	20.00	2	10
Electrical equipment installers and repairers	741	1.67	1.50	1.54	1.57	2.06	1.72	1.60	2.21	-0.61	2.78	2	36
Electronics and telecommunications installers and repairers	742	1.79	1.52	1.86	1.64	2.23	1.88	1.60	2.99	0.29	0.00	3	26
Food processing and related trades workers	751	1.55	1.94	2.09	1.64	1.84	1.60	1.75	1.22	-1.42	48.39	1	31
Garment and related trades workers	753	1.55	0.98	1.61	1.41	1.55	1.13	1.32	1.22	-2.40	66.67	1	27
Mining and mineral processing plant operators	811	1.48	1.07	1.54	0.63	1.86	1.80	1.50	2.29	-1.22	0.00	1	11
Metal processing and finishing plant operators	812	1.37	0.86	1.24	1.74	1.45	1.82	1.37	1.22	-2.73	5.26	1	19
Chemical and photographic products plant and machine operators	813	2.11	1.51	1.61	1.64	1.95	1.61	1.43	2.33	-0.29	36.36	3	11
Rubber, plastic and paper products machine operators	814	1.82	1.06	1.38	1.81	1.23	1.35	1.41	1.93	-1.92	12.50	3	24
Textile, fur and leather products machine operators	815	1.55	1.01	1.86	1.32	1.86	1.61	1.75	1.74	-1.63	35.71	1	14

Other stationary plant and machine operators	818	1.59	1.64	1.54	2.01	1.82	1.64	1.34	2.30	-0.78	21.15	2	52
Assemblers	821	1.70	1.09	1.47	1.53	1.68	1.26	1.32	1.93	-1.50	39.68	2	63
Car, van and motorcycle drivers	832	1.09	0.88	2.40	1.15	1.38	0.80	1.41	1.11	-3.10	4.84	1	62
Heavy truck and bus drivers	833	1.52	0.93	1.47	1.10	1.60	1.17	1.50	1.86	-1.90	1.06	1	94
Mobile plant operators	834	1.20	1.09	1.54	0.84	1.56	1.64	1.42	1.59	-2.30	0.00	1	29
Domestic, hotel and office cleaners and helpers	911	0.24	1.59	1.56	0.90	0.93	0.73	1.32	1.00	-3.87	91.49	1	47
Vehicle, window, laundry and other hand cleaning workers	912	1.18	1.09	2.13	1.15	1.65	1.37	1.75	1.00	-2.67	42.86	1	14
Agricultural, forestry and fishery labourers	921	0.72		0.75	0.97	0.59	0.73	1.20	0.95		58.82	1	17
Mining and construction labourers	931	1.66	1.29	0.93	1.74	1.02	1.39	1.19	1.61	-2.37	2.38	2	42
Manufacturing labourers	932	1.31	1.18	1.04	1.30	1.13	0.96	1.22	1.25	-2.88	80.56	1	108
Transport and storage labourers	933	1.55	0.78	1.39	1.58	1.91	1.63	1.75	1.73	-1.74	55.26	1	38
Food preparation assistants	941	1.55	0.74	1.17	1.35	0.53	1.08	1.28	1.19	-3.71	91.49	1	47
Refuse workers	961	1.15		0.83	0.82	0.78	0.99	1.25	2.78		36.84	1	19
Other elementary workers	962	1.55	0.79	1.49	1.41	1.66	1.47	1.41	2.01	-1.80	31.03	1	58
NETHERLANDS	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Legislators and senior officials	111	2.05	2.10	2.22	2.33	2.77	2.59	2.41	2.13	0.81	18.18	3	11
Managing directors and chief executives	112	2.35	2.45	2.50	2.30	2.64	2.65	2.71	2.13	1.15	10.78	4	102
Business services and administration managers	121	2.17	2.61	2.40	1.84	2.54	2.42	2.41	2.21	1.08	46.88	4	64
Sales, marketing and development managers	122	2.92	2.98	2.83	2.16	2.91	2.93	3.01	2.53	2.58	23.40	4	47
Manufacturing, mining, construction, and distribution managers	132	2.37	2.45	2.31	1.74	2.54	2.58	3.01	2.36	1.24	7.14	4	42
Information and communications technology service managers	133	2.30	2.99	2.71	2.17	2.53	2.65	3.01	2.36	1.53	16.67	4	12
Professional services managers	134	2.06	2.47	2.31	1.93	2.57	2.69	3.01	2.56	1.20	41.83	3	153
Hotel and restaurant managers	141	1.40	1.61	2.31	1.98	1.89	2.28	1.96	1.85	-1.22	27.27	1	11
Retail and wholesale trade managers	142	2.37	1.63	2.21	1.96	2.16	2.78	3.73	1.93	-0.07	47.22	4	36
Other services managers	143	1.93	2.69	2.80	1.64	2.64	2.52	1.96	2.05	0.93	38.46	3	13
Life science professionals	213	2.80	2.62	2.40	1.85	2.91	2.06	1.75	2.29	2.06	18.18	4	11
Engineering professionals (excluding electrotechnology)	214	3.31	2.32	2.24	1.89	2.45	1.86	1.75	2.41	1.84	19.44	4	36
Architects, planners, surveyors and designers	216	2.26	2.32	2.31	1.83	2.52	2.11	1.96	1.91	0.70	4.00	4	25
Medical doctors	221	2.03	2.32	1.71	2.04	2.88	2.40	1.96	2.51	1.38	56.00	3	25

Nursing and midwifery professionals	222	1.70	1.71	1.71	2.00	2.39	2.36	2.41	3.28	0.75	76.47	2	51
Other health professionals	226	1.78	1.79	2.13	1.85	2.46	2.15	1.75	2.53	0.37	72.00	2	50
University and higher education teachers	231	1.83	2.30	2.03	2.26	3.29	2.66	3.01	2.29	1.48	47.37	3	19
Vocational education teachers	232	1.69	2.32	1.63	1.80	2.55	2.39	1.96	2.18	0.48	57.14	2	14
Secondary education teachers	233	1.72	1.88	1.52	2.17	2.66	2.54	1.75	2.23	0.36	47.50	2	40
Primary school and early childhood teachers	234	1.58	1.76	1.35	2.17	2.55	2.20	1.80	2.11	-0.04	86.36	2	66
Other teaching professionals	235	1.31	1.89	1.77	1.96	2.47	2.28	1.91	2.07	-0.29	73.81	1	84
Finance professionals	241	3.17	2.62	2.21	1.93	2.59	2.31	2.18	2.45	2.12	34.78	4	46
Administration professionals	242	1.96	2.32	2.31	2.01	2.57	2.32	2.05	2.44	0.92	42.86	3	91
Sales, marketing and public relations professionals	243	2.31	2.72	2.52	2.07	2.54	2.21	1.75	2.51	1.49	50.00	4	34
Software and applications developers and analysts	251	2.60	2.62	2.31	2.26	2.39	2.07	1.75	2.27	1.30	12.12	4	66
Database and network professionals	252	2.26	2.93	1.89	2.11	2.37	1.98	1.75	2.21	1.18	2.86	4	35
Legal professionals	261	1.93	2.10	2.13	2.23	2.81	2.26	1.75	2.26	0.87	55.56	3	18
Social and religious professionals	263	1.47	1.98	2.18	2.17	2.20	2.06	1.96	2.51	-0.06	75.81	1	62
Authors, journalists and linguists	264	1.85	2.10	2.40	1.74	2.58	1.76	1.75	2.05	0.39	60.87	3	23
Creative and performing artists	265	1.53	1.76	2.75	1.90	2.55	1.89	1.75	1.66	-0.44	52.63	1	19
Physical and engineering science technicians	311	3.01	2.30	1.83	1.89	2.40	1.74	1.75	2.21	1.37	6.06	4	33
Mining, manufacturing and construction supervisors	312	2.15	2.30	2.22	2.03	2.16	2.35	3.73	2.23	0.45	2.86	3	35
Process control technicians	313	2.09	1.61	1.39	1.82	1.95	1.67	1.75	2.23	-0.30	9.68	3	31
Medical and pharmaceutical technicians	321	1.87	1.52	1.54	2.30	2.11	1.64	1.75	2.23	-0.37	60.00	3	20
Nursing and midwifery associate professionals	322	1.75	1.50	1.47	1.83	2.19	2.08	1.96	2.65	-0.06	100.00	2	20
Other health associate professionals	325	1.62	1.67	1.77	1.85	2.13	2.05	1.75	2.08	-0.57	71.43	2	56
Financial and mathematical associate professionals	331	2.51	2.30	2.15	1.68	2.34	1.98	1.75	2.07	0.81	48.72	4	39
Sales and purchasing agents and brokers	332	2.61	2.56	2.31	1.93	2.48	2.20	1.78	2.25	1.36	26.87	4	67
Business services agents	333	2.17	2.32	2.40	1.85	2.33	2.15	2.41	2.36	0.76	44.90	4	49
Administrative and specialised secretaries	334	1.81	2.52	2.22	1.74	2.26	1.81	2.58	2.13	0.34	84.13	3	63
Regulatory government associate professionals	335	2.05	2.08	2.21	2.13	2.68	2.21	1.75	2.73	1.18	41.82	3	55
Legal, social and religious associate professionals	341	1.13	1.62	1.78	2.04	2.24	2.32	1.96	2.91	-0.21	76.92	1	91
Sports and fitness workers	342	1.06	0.98	2.06	1.87	1.69	2.48	1.49	2.27	-1.82	63.64	1	11

General office clerks	411	1.79	1.98	1.80	1.74	1.79	1.61	1.75	1.77	-0.83	72.22	3	72
Secretaries (general)	412	1.41	2.09	2.02	1.74	2.02	1.57	1.96	1.93	-0.68	100.00	1	36
Client information workers	422	1.81	1.89	1.54	2.04	2.07	1.88	1.75	1.93	-0.44	72.22	3	72
Numerical clerks	431	2.26	2.30	2.22	1.48	1.88	1.38	1.75	1.91	-0.03	85.33	4	75
Material-recording and transport clerks	432	2.20	1.96	1.80	1.84	1.93	1.98	1.96	1.84	-0.30	27.17	4	92
Other clerical support workers	441	1.86	1.99	1.67	1.64	1.87	1.38	1.75	1.87	-0.60	60.47	3	43
Cooks	512	1.40	1.12	2.31	2.00	1.51	1.67	1.86	1.04	-2.59	50.00	1	16
Waiters and bartenders	513	1.54	0.98	1.46	1.84	1.29	1.59	1.75	1.00	-2.85	66.67	2	30
Hairdressers, beauticians and related workers	514	1.40	1.44	1.86	1.19	1.96	1.81	1.75	1.41	-1.60	100.00	1	16
Building and housekeeping supervisors	515	1.37	1.72	2.21	1.57	1.88	1.62	2.41	1.59	-1.38	31.82	1	22
Shop salespersons	522	1.74	1.24	1.62	1.90	1.94	1.90	1.75	1.55	-1.38	67.48	2	123
Cashiers and ticket clerks	523	1.20	1.07	1.10	1.42	1.50	1.25	1.11	1.63	-2.35	91.67	1	12
Other sales workers	524	1.74	2.57	1.80	1.99	1.93	1.72	1.75	1.77	-0.32	61.11	2	36
Child care workers and teachers' aides	531	0.95	1.20	1.51	1.85	1.94	1.78	1.75	1.79	-1.85	94.34	1	53
Personal care workers in health services	532	1.04	1.18	1.43	1.64	1.80	1.75	1.50	2.53	-1.37	96.46	1	113
Protective services workers	541	0.76	1.92	1.54	1.74	2.20	1.97	1.48	2.73	-0.49	25.42	1	59
Market gardeners and crop growers	611	2.18	1.84	2.13	2.05	2.01	1.78	1.86	1.57	-0.52	25.00	4	24
Animal producers	612	2.00	1.40	2.66	1.61	2.50	1.72	2.41	1.39	-0.56	12.50	3	16
Building frame and related trades workers	711	1.64	1.23	1.87	1.75	1.52	1.63	1.49	1.17	-2.23	0.00	2	43
Building finishers and related trades workers	712	1.59	1.32	1.80	2.05	1.33	1.41	1.75	1.45	-2.19	0.00	2	27
Painters, building structure cleaners and related trades workers	713	1.47	2.30	1.39	1.53	0.89	1.34	2.38	1.00	-2.46	8.33	1	12
Sheet and structural metal workers, moulders and welders, and related workers	721	1.90	1.12	1.57	1.61	1.33	0.99	1.52	1.00	-2.43	5.00	3	20
Blacksmiths, toolmakers and related trades workers	722	2.11	0.84	1.54	2.17	1.39	1.16	1.75	2.66	-1.09	0.00	3	14
Machinery mechanics and repairers	723	1.66	1.02	1.61	2.21	1.77	1.42	1.75	1.79	-1.58	0.00	2	29
Electrical equipment installers and repairers	741	1.66	1.20	1.66	1.93	1.94	1.56	1.75	1.85	-1.25	0.00	2	34
Food processing and related trades workers	751	1.67	1.32	1.16	1.75	1.49	1.70	1.44	1.17	-2.17	31.25	2	16
Wood treaters, cabinet-makers and related trades workers	752	1.53	0.86	1.54	2.30	1.27	1.67	1.55	1.00	-2.97	10.00	2	10
Garment and related trades workers	753	1.45	1.58	2.04	0.88	1.12	0.99	1.75	0.95	-2.74	80.00	1	10
Other craft and related workers	754	1.62	1.31	1.97	1.72	2.06	1.73	3.01	1.56	-1.29	46.15	2	13

Car, van and motorcycle drivers	832	2.03	1.10	1.07	1.51	1.56	1.30	1.36	1.61	-1.61	14.29	3	21
Heavy truck and bus drivers	833	1.43	1.18	1.15	1.57	1.61	0.89	1.40	1.00	-2.46	0.00	1	38
Mobile plant operators	834	1.60	1.11	1.37	1.65	1.59	0.98	1.27	1.00	-2.38	12.50	2	16
Domestic, hotel and office cleaners and helpers	911	0.96	1.07	1.78	0.84	0.88	0.91	1.44	1.17	-3.58	83.54	1	79
Agricultural, forestry and fishery labourers	921	1.38	1.01	1.17	1.68	1.47	1.31	1.75	0.94	-2.82	43.75	1	16
Manufacturing labourers	932	1.76	0.25	1.25	1.90	0.79	0.93	1.07	0.47	-4.13	66.67	2	15
Transport and storage labourers	933	1.20	1.28	1.21	1.74	1.15	1.14	1.39	1.00	-3.08	21.43	1	42
Food preparation assistants	941	1.55	0.85	0.96	1.76	1.08	1.27	1.17	1.00	-3.16	69.23	2	13
Other elementary workers	962	1.20	0.79	1.39	1.77	1.28	1.42	1.40	1.03	-3.24	32.00	1	25
NORWAY	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Managing directors and chief executives	112	2.57	2.55	3.22	2.16	2.72	2.60	2.41	2.21	1.54	11.76	4	34
Business services and administration managers	121	2.50	2.95	2.94	2.17	2.82	2.59	2.23	2.44	2.05	41.67	4	48
Sales, marketing and development managers	122	2.20	2.56	2.31	2.23	2.78	2.72	3.01	2.53	1.57	40.00	4	85
Manufacturing, mining, construction, and distribution managers	132	2.37	2.45	2.80	2.23	2.66	2.85	3.01	2.38	1.39	10.64	4	47
Professional services managers	134	2.63	2.51	2.28	1.93	2.52	2.87	2.71	2.25	1.38	50.00	4	12
Retail and wholesale trade managers	142	2.55	2.25	2.59	2.04	2.58	2.74	3.01	2.21	1.18	12.50	4	24
Life science professionals	213	2.36	2.82	2.50	2.28	2.72	2.22	1.75	2.21	1.57	28.00	4	75
Engineering professionals (excluding electrotechnology)	214	2.81	2.70	2.31	2.17	2.73	2.36	1.96	2.44	2.03	24.19	4	62
Architects, planners, surveyors and designers	216	1.96	2.32	2.21	2.58	2.60	2.01	1.75	2.21	0.76	33.33	3	18
Medical doctors	221	2.26	1.91	2.08	2.54	2.85	2.70	1.39	3.24	1.81	20.00	4	20
Nursing and midwifery professionals	222	1.57	1.38	1.75	2.17	2.37	2.28	1.96	3.10	0.26	91.89	1	74
Other health professionals	226	1.57	2.00	2.27	2.30	2.69	2.44	1.96	2.46	0.53	53.33	1	30
University and higher education teachers	231	1.91	2.53	2.71	2.30	3.13	2.36	1.96	2.27	1.50	55.17	3	29
Vocational education teachers	232	1.88	2.02	1.78	2.04	2.82	3.05	3.01	2.29	0.82	42.11	3	19
Secondary education teachers	233	1.63	1.94	1.86	2.17	2.47	2.93	2.49	2.01	-0.06	44.74	2	38
Primary school and early childhood teachers	234	1.57	1.71	1.86	2.17	2.45	2.97	2.58	2.05	-0.25	80.34	1	178
Other teaching professionals	235	1.53	1.76	2.01	2.05	2.28	2.75	1.96	2.10	-0.39	71.05	1	38
Finance professionals	241	2.68	3.35	2.13	2.30	2.74	2.57	2.08	2.47	2.40	40.00	4	10
Administration professionals	242	2.06	2.69	2.31	2.17	2.54	2.34	1.96	2.38	1.17	47.50	3	40

Sales, marketing and public relations professionals	243	2.39	2.74	2.40	2.30	2.70	2.49	1.96	2.44	1.69	26.32	4	38
Legal professionals	261	1.63	2.10	2.70	2.35	2.79	2.49	1.96	2.36	0.68	50.00	2	18
Social and religious professionals	263	2.17	2.18	2.31	2.17	2.50	1.84	1.96	2.38	0.86	60.38	4	53
Authors, journalists and linguists	264	1.82	2.45	2.23	1.99	2.65	1.96	2.18	2.40	0.95	60.00	3	20
Creative and performing artists	265	1.41	1.48	2.74	2.59	2.12	2.34	1.46	1.63	-1.22	27.27	1	11
Physical and engineering science technicians	311	2.33	2.32	2.24	2.05	2.60	2.20	1.80	2.21	1.07	12.23	4	139
Mining, manufacturing and construction supervisors	312	2.06	2.58	2.43	2.17	2.63	2.12	1.75	2.04	0.94	15.38	3	39
Ship and aircraft controllers and technicians	315	1.99	1.56	2.05	2.17	2.77	2.12	1.75	2.35	0.58	8.70	3	23
Medical and pharmaceutical technicians	321	2.09	1.39	1.86	2.23	2.44	1.96	1.38	2.10	-0.03	78.57	3	14
Nursing and midwifery associate professionals	322	1.60	1.23	1.55	2.17	2.23	2.24	1.75	3.18	0.10	89.71	2	68
Other health associate professionals	325	1.59	1.48	2.21	1.82	2.42	1.87	1.39	2.47	-0.10	56.52	2	23
Financial and mathematical associate professionals	331	2.27	2.56	2.18	2.44	2.44	2.23	1.75	2.25	1.04	57.69	4	26
Sales and purchasing agents and brokers	332	2.50	2.60	2.31	1.99	2.57	2.33	1.75	2.35	1.47	47.27	4	55
Business services agents	333	2.32	2.46	2.31	2.17	2.45	2.32	2.41	2.22	1.01	50.00	4	18
Administrative and specialised secretaries	334	1.92	2.56	2.13	2.17	2.44	2.14	1.96	2.23	0.75	78.43	3	51
Regulatory government associate professionals	335	1.48	1.80	1.97	2.01	2.23	1.85	1.55	1.93	-0.60	70.37	1	27
Legal, social and religious associate professionals	341	2.00	1.97	2.18	2.17	2.41	2.11	1.75	2.38	0.48	65.12	3	86
Artistic, cultural and culinary associate professionals	343	1.98	1.79	2.40	2.45	2.42	2.11	1.86	1.84	-0.06	69.23	3	13
General office clerks	411	1.91	2.00	2.06	1.83	2.14	1.83	1.75	1.93	-0.21	77.78	3	45
Secretaries (general)	412	1.58	2.10	2.32	2.05	2.13	1.63	1.48	2.07	-0.30	93.33	2	15
Client information workers	422	1.89	1.93	1.92	1.92	2.24	2.08	1.43	2.00	-0.11	73.33	3	30
Numerical clerks	431	2.18	2.15	2.40	1.75	2.24	1.45	1.75	2.07	0.33	88.24	4	34
Material-recording and transport clerks	432	1.64	1.57	2.05	1.93	2.11	1.89	1.40	1.93	-0.75	15.22	2	46
Cooks	512	1.74	1.42	2.40	1.94	2.40	2.03	1.50	1.51	-0.77	59.26	2	27
Waiters and bartenders	513	1.64	1.30	1.56	2.25	2.11	1.96	1.27	1.82	-1.02	85.42	2	48
Building and housekeeping supervisors	515	1.60	1.26	2.55	1.85	2.13	1.82	1.96	1.87	-1.02	0.00	2	16
Other personal services workers	516	1.20	1.32	1.36	1.93	1.98	2.09	1.75	2.24	-1.17	50.00	1	10
Shop salespersons	522	1.79	1.32	2.11	2.17	2.06	2.04	1.37	1.55	-1.15	67.10	2	155
Other sales workers	524	2.08	1.77	2.18	1.86	2.12	2.29	1.58	2.07	-0.15	42.31	3	26

Child care workers and teachers' aides	531	1.18	1.06	1.71	2.17	2.02	2.15	1.30	1.61	-1.80	83.04	1	112
Personal care workers in health services	532	0.96	1.05	1.72	2.17	2.09	1.79	1.39	2.60	-1.16	79.87	1	149
Protective services workers	541	1.13	1.56	1.47	2.05	2.30	2.70	1.65	2.88	-0.22	21.74	1	23
Animal producers	612	1.68	1.40	2.60	2.35	2.60	1.82	2.18	1.64	-0.51	25.00	2	20
Fishery workers, hunters and trappers	622	1.78	1.29	2.93	1.47	1.90	1.46	1.75	1.91	-1.07	9.09	2	11
Building frame and related trades workers	711	1.86	1.23	2.22	1.93	1.79	1.75	1.65	1.52	-1.48	0.00	3	64
Building finishers and related trades workers	712	1.50	1.16	1.80	2.05	2.13	1.91	1.65	2.07	-1.01	1.96	1	51
Sheet and structural metal workers, moulders and welders, and related workers	721	1.77	1.12	2.39	2.17	2.39	1.56	1.34	1.36	-1.09	7.69	2	13
Machinery mechanics and repairers	723	1.59	1.21	2.19	2.13	2.45	1.94	1.58	2.19	-0.46	3.70	2	54
Electrical equipment installers and repairers	741	1.90	1.54	2.30	2.01	2.39	2.04	1.96	2.38	0.09	1.56	3	64
Mining and mineral processing plant operators	811	1.58	1.99	1.54	2.18	2.66	2.09	2.49	2.64	0.65	6.25	1	16
Chemical and photographic products plant and machine operators	813	1.65	1.91	1.51	2.05	2.35	1.80	1.50	2.66	0.32	20.00	2	10
Food and related products machine operators	816	0.96	0.89	1.66	1.42	1.81	1.71	1.44	1.41	-2.49	15.38	1	13
Car, van and motorcycle drivers	832	1.55	1.14	1.86	2.04	1.91	1.12	1.31	1.61	-1.59	5.26	1	19
Heavy truck and bus drivers	833	1.48	1.08	1.96	1.83	2.04	1.67	1.75	1.55	-1.58	4.55	1	44
Mobile plant operators	834	1.38	1.30	1.78	2.16	1.82	1.45	1.47	1.98	-1.41	0.00	1	11
Domestic, hotel and office cleaners and helpers	911	1.04	1.16	1.98	1.35	1.62	1.41	1.25	1.17	-2.63	77.55	1	49
Food preparation assistants	941	1.80	1.24	2.29	1.47	1.96	1.79	1.47	1.03	-1.71	61.54	2	13
POLAND	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Managing directors and chief executives	112	2.92	2.58	2.77	1.96	2.71	2.63	3.01	2.21	1.84	31.19	4	109
Business services and administration managers	121	2.61	2.32	2.05	1.90	2.59	2.43	3.73	2.21	1.28	61.29	4	31
Sales, marketing and development managers	122	2.74	2.93	2.60	2.04	2.44	2.60	3.01	2.67	2.00	40.91	4	22
Manufacturing, mining, construction, and distribution managers	132	2.53	2.32	2.22	1.74	2.27	2.64	3.73	2.42	1.03	16.67	4	30
Professional services managers	134	2.95	2.45	2.36	2.15	2.73	2.91	3.73	2.23	1.82	59.26	4	27
Hotel and restaurant managers	141	2.92	2.02	2.09	1.90	2.27	3.08	3.73	2.51	1.21	68.75	4	16
Retail and wholesale trade managers	142	2.52	2.22	2.45	1.78	2.32	2.78	3.73	2.21	0.85	46.67	4	30
Other services managers	143	2.30	2.19	2.22	2.04	2.28	2.35	3.73	2.21	0.61	33.33	4	15
Engineering professionals (excluding electrotechnology)	214	2.57	2.42	1.78	2.43	2.48	2.26	1.87	2.21	1.20	13.16	4	38
Architects, planners, surveyors and designers	216	2.25	2.56	2.13	1.77	2.40	1.80	1.75	1.77	0.60	48.28	4	29

Medical doctors	221	2.74	1.21	1.51	4.16	2.99	2.27	1.78	2.99	1.67	40.00	4	10
Nursing and midwifery professionals	222	1.77	0.96	1.62	2.12	2.17	2.09	1.86	2.99	-0.18	100.00	3	39
Other health professionals	226	1.46	1.53	2.13	1.85	2.20	1.87	1.75	1.52	-1.14	83.78	1	37
University and higher education teachers	231	1.94	2.12	2.08	2.08	3.55	2.47	1.70	2.27	1.71	50.00	3	20
Vocational education teachers	232	2.11	1.68	1.95	2.03	2.95	3.28	3.37	2.30	0.92	50.00	3	10
Secondary education teachers	233	1.77	1.54	1.78	2.05	2.59	2.69	1.96	2.01	-0.08	84.75	3	59
Primary school and early childhood teachers	234	1.65	1.34	1.95	2.26	2.64	2.51	1.96	1.97	-0.28	93.75	2	96
Other teaching professionals	235	1.58	1.56	2.13	1.93	2.25	2.13	1.75	1.91	-0.67	80.95	2	42
Finance professionals	241	3.59	2.62	2.13	2.04	2.31	1.89	1.75	2.23	1.98	64.52	4	31
Administration professionals	242	2.48	2.60	2.13	2.04	2.43	2.02	1.96	2.38	1.32	67.19	4	64
Sales, marketing and public relations professionals	243	2.94	2.84	2.41	2.17	2.48	2.54	2.41	2.53	2.03	50.00	4	58
Software and applications developers and analysts	251	2.15	2.62	2.18	2.30	2.49	1.72	1.75	2.38	1.14	7.50	4	40
Database and network professionals	252	1.90	2.55	1.96	1.96	2.45	1.93	1.96	2.29	0.78	25.00	3	20
Legal professionals	261	1.80	2.23	2.28	2.92	2.93	2.27	1.75	2.38	1.07	66.67	3	24
Social and religious professionals	263	1.91	2.35	2.23	2.17	2.86	1.93	1.96	2.16	0.99	66.67	3	12
Authors, journalists and linguists	264	1.43	2.06	2.40	1.67	2.61	1.44	1.75	1.95	-0.02	76.92	1	13
Creative and performing artists	265	1.14	1.58	2.20	2.59	2.11	1.79	1.75	1.22	-1.70	45.45	1	11
Armed forces occupations, other ranks	310	1.72	1.03	1.39	2.30	1.97	1.99	1.75	2.03	-1.13	0.00	3	23
Physical and engineering science technicians	311	2.60	2.02	1.62	1.99	2.19	1.57	1.75	2.07	0.53	39.68	4	63
Mining, manufacturing and construction supervisors	312	1.96	1.48	1.80	2.17	1.97	2.79	3.73	2.27	-0.45	12.12	3	33
Process control technicians	313	2.03	1.76	1.54	1.64	1.89	1.39	1.41	1.78	-0.67	6.67	3	15
Medical and pharmaceutical technicians	321	2.05	1.24	1.68	2.30	1.92	1.75	1.75	1.93	-0.86	88.89	3	18
Other health associate professionals	325	1.69	1.57	1.89	1.93	2.07	1.85	1.75	2.02	-0.68	56.00	2	25
Financial and mathematical associate professionals	331	2.52	2.62	1.96	1.93	2.34	1.65	1.75	2.38	1.26	91.80	4	61
Sales and purchasing agents and brokers	332	2.43	2.44	2.31	1.85	2.28	2.38	1.75	2.53	1.13	36.36	4	66
Business services agents	333	2.51	2.74	2.32	1.93	2.57	2.39	1.86	2.24	1.49	57.14	4	28
Administrative and specialised secretaries	334	2.13	2.01	2.06	1.62	2.24	1.59	1.75	2.19	0.28	81.25	3	48
Regulatory government associate professionals	335	1.59	2.02	1.43	1.85	2.34	1.83	1.75	2.23	0.01	64.10	2	39
Legal, social and religious associate professionals	341	1.50	1.47	1.71	1.74	2.23	1.94	1.75	2.23	-0.56	86.67	2	15

Sports and fitness workers	342	1.92	1.57	2.56	2.26	2.37	2.58	2.38	1.74	-0.38	16.67	3	12
Artistic, cultural and culinary associate professionals	343	2.00	1.92	2.32	2.21	1.95	2.14	3.37	2.08	-0.29	61.11	3	18
Information and communications technology operations and user support technicians	351	2.33	2.93	2.22	2.04	2.41	1.85	2.41	2.73	1.68	15.38	4	13
General office clerks	411	1.99	2.19	1.95	1.85	2.26	1.64	1.75	2.19	0.32	81.69	3	71
Secretaries (general)	412	1.65	1.89	1.89	2.07	2.10	1.44	1.75	1.92	-0.54	94.74	2	19
Keyboard operators	413	1.48	1.84	1.88	2.17	1.87	1.77	1.75	2.43	-0.57	80.00	2	15
Tellers, money collectors and related clerks	421	2.09	1.72	1.47	1.97	2.01	1.89	1.75	2.17	-0.21	85.29	3	34
Client information workers	422	2.06	1.86	1.67	1.85	2.03	1.97	1.75	2.50	0.14	71.74	3	46
Numerical clerks	431	2.87	2.23	1.80	1.83	2.10	1.66	1.75	2.05	0.76	84.91	4	53
Material-recording and transport clerks	432	1.66	1.44	1.75	1.61	1.46	1.51	1.75	1.87	-1.59	13.82	2	123
Other clerical support workers	441	1.54	1.51	2.13	1.41	1.62	1.53	1.75	1.98	-1.37	35.71	2	28
Cooks	512	1.54	1.11	1.96	1.80	0.84	1.49	1.75	1.65	-2.76	41.94	2	31
Waiters and bartenders	513	1.76	1.02	1.63	1.81	1.50	2.05	1.75	1.67	-1.90	75.61	3	41
Hairdressers, beauticians and related workers	514	1.55	0.92	1.95	2.03	2.23	2.01	1.75	1.41	-1.54	90.48	2	42
Building and housekeeping supervisors	515	2.56	1.39	1.96	1.51	1.87	1.74	1.75	1.45	-0.78	46.67	4	15
Shop salespersons	522	2.01	1.42	1.89	1.64	1.68	1.97	1.75	1.84	-1.10	72.84	3	335
Cashiers and ticket clerks	523	1.66	1.28	1.89	1.74	1.57	1.79	1.75	1.74	-1.68	92.86	2	56
Other sales workers	524	2.22	2.02	1.96	1.74	1.81	2.05	1.75	1.93	-0.30	50.00	4	74
Child care workers and teachers' aides	531	0.96	0.94	1.44	2.44	1.75	1.74	1.75	0.92	-2.90	100.00	1	18
Personal care workers in health services	532	1.59	1.68	1.47	1.64	1.70	1.46	1.75	1.36	-1.61	94.12	2	17
Protective services workers	541	1.20	1.18	1.67	1.77	1.83	1.77	1.75	2.38	-1.33	6.82	1	88
Market gardeners and crop growers	611	1.58	1.29	2.92	1.66	1.73	1.15	1.75	0.74	-2.33	28.57	2	63
Animal producers	612	1.77	0.99	2.40	1.88	1.78	1.14	1.75	0.81	-2.28	37.14	3	35
Mixed crop and animal producers	613	1.42	1.12	2.45	1.53	1.48	0.79	1.75	0.55	-2.99	37.50	1	80
Building frame and related trades workers	711	1.45	1.22	1.54	1.79	1.07	1.26	1.75	1.00	-3.00	0.55	1	182
Building finishers and related trades workers	712	1.44	1.43	1.71	1.85	1.30	1.80	1.75	0.95	-2.67	1.35	1	74
Painters, building structure cleaners and related trades workers	713	0.71	1.00	1.39	1.35	0.99	1.46	1.75	0.88	-3.93	3.45	1	29
Sheet and structural metal workers, moulders and welders, and related workers	721	1.43	1.07	1.30	2.17	1.07	1.19	1.75	1.32	-2.88	0.00	1	53
Blacksmiths, toolmakers and related trades workers	722	1.66	0.88	1.53	1.69	1.07	1.23	1.75	1.14	-2.97	5.48	2	73

Machinery mechanics and repairers	723	1.55	1.15	1.95	1.93	1.57	1.76	1.75	1.28	-2.21	0.00	2	91
Handicraft workers	731	1.86	1.16	2.32	1.41	1.56	1.49	1.75	1.22	-2.01	38.46	3	13
Printing trades workers	732	1.76	1.30	1.91	1.72	1.85	1.47	1.75	2.06	-1.03	30.77	3	13
Electrical equipment installers and repairers	741	1.43	1.25	1.87	2.05	1.66	1.70	1.75	1.88	-1.67	0.00	1	51
Electronics and telecommunications installers and repairers	742	1.69	1.63	2.40	2.23	2.29	1.67	1.75	1.72	-0.63	4.35	2	23
Food processing and related trades workers	751	1.20	0.88	1.01	1.64	0.53	1.27	1.75	1.22	-3.87	20.93	1	43
Wood treaters, cabinet-makers and related trades workers	752	1.79	0.78	1.64	1.75	1.07	1.12	1.75	1.22	-2.87	6.00	3	50
Garment and related trades workers	753	1.07	0.81	1.16	1.45	0.53	1.35	1.75	1.00	-4.18	68.75	1	32
Other craft and related workers	754	1.46	1.20	1.95	1.83	1.33	1.13	1.75	1.93	-2.01	18.18	2	11
Mining and mineral processing plant operators	811	1.28	1.02	1.47	2.17	1.33	1.68	1.75	1.59	-2.54	0.00	1	31
Metal processing and finishing plant operators	812	1.35	0.77	1.98	1.79	1.41	1.47	1.96	1.00	-3.01	10.00	1	10
Chemical and photographic products plant and machine operators	813	1.40	1.43	1.87	1.69	1.50	0.93	1.41	2.20	-1.50	16.67	1	12
Rubber, plastic and paper products machine operators	814	1.39	1.02	1.59	1.18	1.07	1.11	1.75	1.67	-2.68	15.63	1	32
Food and related products machine operators	816	2.15	0.98	0.91	2.17	0.99	1.52	1.75	2.33	-1.67	41.67	4	12
Other stationary plant and machine operators	818	1.20	0.62	1.47	1.41	0.97	1.26	1.25	1.84	-3.08	40.74	1	27
Assemblers	821	1.27	0.86	1.14	1.48	1.07	1.10	1.75	1.22	-3.23	31.15	1	61
Locomotive engine drivers and related workers	831	1.04	1.88	0.90	1.52	1.68	0.99	1.75	2.28	-1.22	27.27	1	11
Car, van and motorcycle drivers	832	1.47	1.07	1.66	1.32	1.28	1.38	1.75	1.22	-2.69	3.13	2	64
Heavy truck and bus drivers	833	1.55	1.12	1.54	1.64	1.57	1.29	1.75	1.86	-1.79	1.20	2	83
Mobile plant operators	834	1.48	0.69	1.47	1.53	0.97	1.41	1.75	1.41	-3.14	3.28	2	61
Domestic, hotel and office cleaners and helpers	911	0.56	0.47	1.70	0.91	0.56	0.85	1.75	0.63	-5.08	85.45	1	55
Vehicle, window, laundry and other hand cleaning workers	912	2.12	1.78	2.00	1.85	1.39	0.78	1.75	1.40	-1.42	10.00	3	10
Agricultural, forestry and fishery labourers	921	0.89	1.21	0.96	1.29	1.38	0.50	1.56	0.51	-3.50	35.71	1	28
Mining and construction labourers	931	1.32	1.08	1.32	1.96	0.63	1.09	1.55	1.52	-3.28	0.00	1	44
Manufacturing labourers	932	1.55	0.87	1.32	1.53	1.10	1.14	1.47	1.42	-2.81	43.90	2	82
Transport and storage labourers	933	1.66	0.82	1.41	1.18	1.44	1.52	1.75	1.54	-2.28	15.38	2	26
Food preparation assistants	941	1.25	2.32	1.39	1.32	0.53	0.79	1.75	1.11	-2.93	70.83	1	24
Refuse workers	961	0.60		1.31	1.64	-0.56	0.11	0.96	0.51		30.00	1	10
Other elementary workers	962	1.73	1.13	1.55	0.84	1.90	1.14	1.75	1.16	-1.81	41.67	3	12

SLOVAK REPUBLIC	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Legislators and senior officials	111	2.29	2.07	1.90	3.26	2.54	2.47	1.75	2.53	1.05	56.25	3	16
Managing directors and chief executives	112	2.46	2.32	2.40	1.87	2.25	2.10	1.96	2.31	0.86	19.05	4	21
Business services and administration managers	121	2.56	2.62	2.40	2.26	2.55	2.75	3.01	2.51	1.63	45.95	4	37
Sales, marketing and development managers	122	3.13	2.74	3.08	2.59	3.03	2.82	2.23	2.50	2.69	27.78	4	18
Manufacturing, mining, construction, and distribution managers	132	2.80	2.15	2.40	2.01	2.28	2.82	3.73	1.98	0.80	6.02	4	83
Information and communications technology service managers	133	2.35	2.77	3.40	2.44	2.90	2.20	1.77	2.23	1.74	14.29	3	14
Professional services managers	134	1.98	2.23	2.40	2.17	2.66	2.34	3.01	2.35	0.90	56.67	3	30
Hotel and restaurant managers	141	2.22	2.18	2.40	1.86	1.85	1.94	3.01	1.95	-0.14	46.67	3	15
Retail and wholesale trade managers	142	2.63	2.62	2.40	2.05	2.40	2.65	2.05	2.26	1.34	33.33	4	51
Other services managers	143	2.40	2.10	2.40	3.45	2.49	2.82	1.75	2.31	0.93	52.94	4	17
Engineering professionals (excluding electrotechnology)	214	2.50	2.14	1.95	2.30	2.26	1.94	1.96	2.30	0.78	16.13	4	31
Electrotechnology engineers	215	2.73	2.71	1.80	2.27	2.56	1.61	1.66	2.68	1.97	7.69	4	13
Architects, planners, surveyors and designers	216	2.20	2.08	2.31	2.23	2.66	1.76	1.75	2.05	0.74	29.17	3	24
Medical doctors	221	1.81	1.73	1.71	2.57	2.60	1.91	1.96	3.00	0.87	77.78	2	18
Other health professionals	226	1.73	1.92	1.80	2.30	2.20	1.90	1.75	2.13	-0.18	82.35	2	17
Vocational education teachers	232	1.91	1.42	1.44	1.86	2.47	2.43	2.71	1.58	-0.51	75.00	3	12
Secondary education teachers	233	1.95	1.65	1.39	2.05	2.45	2.56	2.41	2.23	0.16	86.67	3	15
Primary school and early childhood teachers	234	1.74	1.53	1.54	2.30	2.41	2.59	2.58	1.84	-0.44	88.37	2	86
Other teaching professionals	235	1.73	1.45	1.80	2.17	2.35	2.70	1.75	1.91	-0.51	71.43	2	49
Finance professionals	241	2.97	2.62	2.40	2.31	2.53	2.20	1.75	2.28	1.77	53.57	4	28
Sales, marketing and public relations professionals	243	1.76	2.02	1.54	1.80	1.96	1.99	1.62	2.19	-0.32	41.18	2	17
Software and applications developers and analysts	251	2.25	2.62	2.22	2.23	2.26	1.78	1.75	2.40	0.99	19.05	3	21
Database and network professionals	252	1.90	2.70	2.20	2.26	2.62	1.90	1.75	1.84	0.73	9.52	2	21
Legal professionals	261	1.06	2.08	2.14	2.43	2.76	2.19	1.70	3.00	0.68	60.00	1	10
Social and religious professionals	263	3.32	2.77	2.22	2.30	2.49	1.66	1.75	2.38	2.17	85.96	4	57
Physical and engineering science technicians	311	2.44	2.02	1.48	2.05	2.31	1.68	1.44	2.35	0.75	13.89	4	36
Mining, manufacturing and construction supervisors	312	2.60	2.00	1.58	2.05	2.11	2.27	3.73	2.40	0.68	22.41	4	58
Process control technicians	313	2.14	1.72	1.62	2.17	1.82	1.98	2.71	1.93	-0.56	18.37	3	49

Life science technicians and related associate professionals	314	2.35	1.49	2.22	2.05	2.28	2.65	2.89	1.95	-0.04	20.00	3	10
Medical and pharmaceutical technicians	321	1.74	1.14	0.97	2.54	2.02	1.02	1.75	1.93	-1.07	88.89	2	18
Nursing and midwifery associate professionals	322	1.57	1.02	1.17	2.26	1.97	2.05	1.75	2.33	-1.02	98.46	2	65
Other health associate professionals	325	1.40	1.22	1.39	2.71	2.29	1.85	1.75	1.69	-1.16	75.00	1	16
Financial and mathematical associate professionals	331	2.97	2.32	1.93	1.93	2.10	1.29	1.75	2.01	0.87	89.06	4	64
Sales and purchasing agents and brokers	332	2.61	2.53	2.36	2.06	2.26	2.44	1.75	2.73	1.47	40.38	4	52
Business services agents	333	2.82	2.62	1.59	2.78	2.72	2.27	1.75	2.63	2.13	66.67	4	18
Administrative and specialised secretaries	334	2.45	2.30	1.84	2.25	2.34	2.17	1.75	2.50	1.10	74.07	4	54
Regulatory government associate professionals	335	2.37	1.84	1.52	2.26	2.19	1.69	1.75	2.60	0.63	74.36	4	39
Information and communications technology operations and user support technicians	351	2.23	3.27	2.30	2.27	2.94	1.93	1.75	2.35	2.12	12.50	3	16
General office clerks	411	2.13	2.11	1.54	2.01	1.79	0.99	1.75	2.73	0.28	83.33	3	12
Keyboard operators	413	1.63	1.82	1.16	1.85	2.02	0.99	1.49	2.00	-0.62	90.00	2	10
Tellers, money collectors and related clerks	421	2.37	2.38	1.20	2.26	2.05	1.89	1.32	2.36	0.65	95.65	3	23
Client information workers	422	2.56	2.06	1.30	2.02	1.75	1.49	1.41	2.73	0.55	72.22	4	18
Numerical clerks	431	2.65	2.23	1.71	1.90	2.06	1.30	1.75	2.07	0.56	95.12	4	41
Material-recording and transport clerks	432	2.37	1.97	1.62	2.17	1.83	1.64	1.75	2.21	0.02	44.64	3	56
Other clerical support workers	441	2.19	2.08	1.59	1.87	2.01	1.88	1.75	2.17	0.11	89.74	3	39
Cooks	512	1.64	0.94	1.39	2.35	1.32	1.03	1.47	1.00	-2.76	67.57	2	37
Waiters and bartenders	513	2.12	1.09	1.42	2.13	1.15	1.59	1.75	1.28	-2.26	71.05	3	38
Hairdressers, beauticians and related workers	514	1.89	1.07	2.30	1.62	2.26	1.59	1.75	0.86	-1.56	100.00	2	17
Building and housekeeping supervisors	515	2.09	2.17	1.88	1.93	1.54	1.25	1.75	1.25	-1.13	23.53	3	17
Shop salespersons	522	2.37	1.53	1.46	2.01	1.36	1.84	1.75	1.43	-1.41	85.28	3	163
Cashiers and ticket clerks	523	1.98	0.86	0.85	2.21	1.47	1.37	1.75	1.00	-2.38	91.30	3	23
Other sales workers	524	2.37	2.07	1.95	2.15	1.95	1.75	1.75	1.48	-0.36	57.89	3	19
Child care workers and teachers' aides	531	1.59	0.87	1.39	2.01	2.05	2.70	3.73	1.26	-1.85	92.31	2	13
Personal care workers in health services	532	1.20	1.07	1.70	1.85	1.63	1.40	1.75	1.19	-2.54	93.33	1	60
Protective services workers	541	1.64	1.80	1.47	1.90	1.83	1.74	1.65	2.33	-0.60	10.45	2	67
Animal producers	612	1.26		1.62	0.84	0.52	1.11	1.35	1.00		53.33	1	15
Building frame and related trades workers	711	1.57	1.43	1.47	2.03	1.22	1.42	1.50	0.98	-2.62	0.00	1	71

Building finishers and related trades workers	712	1.31	1.19	1.55	1.90	1.19	1.50	1.56	1.00	-3.00	0.00	1	41
Painters, building structure cleaners and related trades workers	713	1.26		1.46	1.90	1.32	0.52	1.75	0.63		0.00	1	11
Sheet and structural metal workers, moulders and welders, and related workers	721	1.50	1.73	0.97	2.04	0.70	1.10	1.33	1.00	-3.03	2.78	1	36
Blacksmiths, toolmakers and related trades workers	722	1.66	1.22	1.55	2.13	1.49	1.15	1.75	1.19	-2.23	2.27	2	44
Machinery mechanics and repairers	723	1.66	1.19	1.37	2.13	1.40	1.05	1.75	1.55	-2.07	3.51	2	57
Electrical equipment installers and repairers	741	1.77	1.59	1.54	1.99	1.69	1.22	1.75	1.86	-1.15	4.17	2	24
Electronics and telecommunications installers and repairers	742	2.10	1.65	1.38	2.17	1.84	1.35	1.75	2.02	-0.55	5.88	3	17
Food processing and related trades workers	751	1.20		1.26	1.72	0.53	0.83	1.23	0.76		57.89	1	19
Wood treaters, cabinet-makers and related trades workers	752	2.02	1.59	1.99	1.85	1.45	1.90	1.75	1.07	-1.83	0.00	3	27
Garment and related trades workers	753	1.36	0.60	0.68	1.80	0.95	0.97	1.32	0.73	-3.85	89.66	1	29
Other craft and related workers	754	1.89	1.12	1.05	2.26	1.34	0.99	1.75	1.41	-2.11	42.86	2	70
Metal processing and finishing plant operators	812	1.70	0.98	0.83	1.64	1.10	0.47	1.23	1.00	-2.94	16.67	2	36
Rubber, plastic and paper products machine operators	814	1.30	0.82	1.01	1.32	0.55	0.79	0.93	1.00	-3.97	29.41	1	17
Wood processing and papermaking plant operators	817	1.20	0.51	1.27	1.56	0.53	2.01	0.89	1.03	-4.27	25.00	1	12
Other stationary plant and machine operators	818	1.20	0.67	0.77	1.75	0.97	0.76	1.25	1.00	-3.69	35.90	1	78
Assemblers	821	1.30	1.09	0.93	1.68	1.26	1.05	1.65	1.00	-3.00	37.50	1	64
Locomotive engine drivers and related workers	831	1.63	0.72	0.94	2.17	1.44	0.67	1.45	1.47	-2.44	7.14	2	14
Car, van and motorcycle drivers	832	1.08	1.21	0.83	1.90	1.16	0.99	1.75	1.36	-2.93	6.67	1	15
Heavy truck and bus drivers	833	1.59	1.28	1.11	1.86	1.40	0.79	1.41	1.50	-2.10	2.25	2	89
Mobile plant operators	834	1.48	0.95	1.05	1.57	1.10	0.79	1.32	1.11	-3.05	0.00	1	36
Domestic, hotel and office cleaners and helpers	911	0.83	1.24	1.54	0.84	0.66	0.68	1.75	0.98	-3.96	95.38	1	65
Mining and construction labourers	931	0.73		0.90	2.05	1.05	0.93	0.72	1.34		0.00	1	12
Manufacturing labourers	932	1.43	0.82	0.83	1.19	0.82	0.99	1.08	1.67	-3.05	65.63	1	32
Transport and storage labourers	933	1.54	1.19	1.27	1.64	1.24	0.77	1.52	1.22	-2.60	12.07	1	58
Food preparation assistants	941	1.66		0.83	1.41	0.64	0.81	1.25	0.47		70.59	2	17
SPAIN	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Sales, marketing and development managers	122	3.13	3.28	2.98	3.61	2.95	2.97	3.01	2.52	2.99	6.25	4	16
Manufacturing, mining, construction, and distribution managers	132	2.50	1.87	2.59	2.03	2.21	2.45	3.73	2.07	0.36	12.90	4	31
Professional services managers	134	2.61	2.62	2.13	2.64	2.94	2.84	3.01	2.73	2.28	39.13	4	46

Hotel and restaurant managers	141	2.37	1.42	3.12	2.95	2.05	2.45	3.73	1.41	-0.74	35.71	4	28
Retail and wholesale trade managers	142	2.50	2.11	2.40	2.33	2.24	2.17	1.75	1.66	0.23	45.16	4	31
Other services managers	143	2.12	2.50	2.40	2.37	3.36	2.13	3.01	2.42	2.01	35.00	3	20
Life science professionals	213	2.09	2.62	2.04	2.30	2.50	1.76	1.75	2.76	1.40	75.00	3	12
Engineering professionals (excluding electrotechnology)	214	3.34	2.62	2.04	3.05	2.60	2.27	3.01	2.53	2.34	14.29	4	21
Architects, planners, surveyors and designers	216	2.75	2.30	1.92	2.79	2.47	2.05	1.86	2.21	1.25	28.57	4	28
Medical doctors	221	1.72	1.76	1.47	4.16	3.12	2.25	1.77	3.69	1.93	40.00	2	25
Nursing and midwifery professionals	222	1.38	1.21	1.43	2.30	2.22	1.97	1.96	2.77	-0.43	88.37	1	43
Other health professionals	226	1.94	1.70	2.00	2.26	2.54	2.21	1.86	2.48	0.49	59.09	3	22
University and higher education teachers	231	2.38	2.27	2.36	2.74	3.74	2.62	3.73	2.58	2.62	57.14	4	14
Vocational education teachers	232	2.81	1.76	1.86	3.06	3.08	3.03	3.01	2.23	1.62	23.08	4	13
Secondary education teachers	233	2.05	2.01	1.70	2.63	3.01	3.08	3.01	2.35	1.20	52.94	3	51
Primary school and early childhood teachers	234	1.73	1.58	1.79	2.79	2.72	2.37	2.79	2.11	0.14	78.13	2	64
Other teaching professionals	235	1.39	1.76	1.70	2.44	2.51	2.40	1.96	1.93	-0.37	73.97	1	73
Finance professionals	241	3.27	2.94	2.13	2.35	2.96	2.17	1.75	2.63	2.98	41.38	4	29
Administration professionals	242	1.57	2.10	1.71	2.44	2.46	3.15	3.01	3.02	0.78	60.00	1	15
Software and applications developers and analysts	251	1.80	2.72	1.54	3.05	2.41	1.64	1.75	2.19	0.69	20.00	2	25
Database and network professionals	252	1.72	2.93	1.95	2.44	2.36	1.79	1.75	2.23	0.75	29.41	2	17
Legal professionals	261	2.03	2.10	1.70	2.82	3.19	2.37	1.75	2.73	1.73	32.43	3	37
Social and religious professionals	263	1.66	2.02	2.09	2.51	2.48	2.27	1.86	2.70	0.58	63.33	2	30
Authors, journalists and linguists	264	2.54	2.62	1.71	2.94	2.91	2.33	1.96	2.73	2.19	36.36	4	11
Armed forces occupations, other ranks	310	1.49	1.46	1.39	2.25	1.73	1.39	1.44	1.86	-1.42	15.38	1	13
Physical and engineering science technicians	311	2.76	2.12	1.67	2.16	2.08	1.58	1.75	1.77	0.36	33.33	4	27
Mining, manufacturing and construction supervisors	312	2.34	2.29	1.70	2.21	1.76	1.87	3.37	2.31	0.21	22.58	4	31
Process control technicians	313	2.22	2.14	1.71	2.04	2.23	1.76	1.96	2.45	0.64	37.50	3	24
Medical and pharmaceutical technicians	321	2.44	1.10	1.80	3.05	2.05	1.39	1.75	2.55	-0.02	61.11	4	18
Nursing and midwifery associate professionals	322	1.69	0.88	1.17	2.51	1.84	1.38	1.75	1.90	-1.50	94.44	2	36
Other health associate professionals	325	1.70	2.02	1.87	2.28	2.20	1.50	1.62	2.42	0.08	52.17	2	23
Sales and purchasing agents and brokers	332	2.74	2.62	2.27	2.44	2.47	2.27	1.75	2.21	1.47	45.31	4	64

Regulatory government associate professionals	335	2.37	2.62	1.47	2.78	2.45	1.70	1.75	2.35	1.25	66.67	4	15
Sports and fitness workers	342	1.46	1.47	1.91	2.09	1.97	2.67	3.01	1.86	-1.18	25.00	1	12
General office clerks	411	2.28	2.32	1.70	2.04	2.00	1.62	1.75	2.22	0.38	71.26	3	167
Secretaries (general)	412	2.29	2.10	2.13	2.25	2.76	1.77	2.09	2.19	1.05	89.47	3	19
Tellers, money collectors and related clerks	421	2.37	1.61	1.11	2.26	1.82	1.83	1.75	2.38	-0.11	69.23	4	26
Client information workers	422	2.20	1.40	1.54	2.25	1.96	1.59	1.75	1.77	-0.71	80.00	3	50
Numerical clerks	431	2.37	2.62	1.97	1.99	2.18	1.28	1.75	2.23	0.86	72.00	4	50
Material-recording and transport clerks	432	1.98	1.88	1.45	1.80	1.61	1.37	1.75	1.96	-0.80	35.62	3	73
Other clerical support workers	441	2.10	2.32	1.62	2.01	2.10	1.96	1.75	2.33	0.43	58.14	3	43
Cooks	512	1.91	1.30	1.67	2.57	1.49	1.59	1.75	1.84	-1.47	60.00	3	35
Waiters and bartenders	513	1.58	1.12	1.70	1.99	1.40	1.75	1.75	1.22	-2.43	53.33	1	75
Hairdressers, beauticians and related workers	514	1.75	1.16	1.68	2.25	2.03	2.04	1.75	1.00	-1.75	96.88	2	32
Building and housekeeping supervisors	515	1.71	1.03	1.96	1.69	1.57	1.14	1.75	1.59	-1.92	28.57	2	21
Shop salespersons	522	2.06	1.61	1.95	2.30	1.88	1.95	1.75	1.72	-0.81	57.14	3	77
Cashiers and ticket clerks	523	2.11	1.10	0.98	1.16	1.27	0.99	1.02	1.00	-2.33	58.33	3	12
Other sales workers	524	2.03	1.37	1.88	2.01	1.56	1.95	1.75	1.41	-1.58	73.83	3	107
Child care workers and teachers' aides	531	1.57	1.11	1.72	1.94	1.02	1.32	1.75	0.95	-3.07	100.00	1	29
Personal care workers in health services	532	1.09	1.59	1.52	1.90	1.22	0.99	1.75	1.54	-2.46	88.89	1	63
Protective services workers	541	1.24	1.47	1.55	2.30	2.13	1.91	1.75	2.65	-0.56	10.39	1	77
Market gardeners and crop growers	11	1.38	0.85	2.21	2.01	1.41	1.11	1.75	1.02	-2.93	8.89	1	45
Animal producers	612	1.19	0.69	2.39	2.59	1.11	1.15	1.75	0.97	-3.56	29.41	1	17
Building frame and related trades workers	711	1.87	1.61	1.63	2.27	1.30	1.39	1.75	1.22	-1.99	0.00	2	85
Building finishers and related trades workers	712	1.70	1.50	2.13	2.19	1.38	1.73	1.75	2.31	-1.26	0.00	2	31
Painters, building structure cleaners and related trades workers	713	1.64	1.02	1.54	2.62	1.41	1.41	1.75	1.31	-2.38	0.00	2	14
Sheet and structural metal workers, moulders and welders, and related workers	721	1.92	0.74	1.73	2.44	1.30	1.31	1.75	1.57	-2.26	0.00	3	44
Machinery mechanics and repairers	723	1.77	1.12	1.87	2.92	1.81	1.65	1.75	1.97	-1.26	0.00	2	50
Printing trades workers	732	1.35	1.14	1.15	2.79	1.61	0.99	1.75	1.67	-2.03	10.00	1	10
Electrical equipment installers and repairers	741	1.92	1.19	2.11	2.57	1.73	1.28	1.75	2.16	-1.03	0.00	3	29
Food processing and related trades workers	751	1.95	1.51	2.04	2.46	1.35	1.38	1.75	1.22	-1.94	30.77	3	39

Garment and related trades workers	753	1.84	1.20	1.38	2.01	1.15	1.48	1.75	0.76	-2.80	84.62	2	13
Other stationary plant and machine operators	818	1.66	0.98	1.09	1.96	0.79	0.55	1.75	1.85	-2.66	16.67	2	24
Car, van and motorcycle drivers	832	1.81	1.27	1.71	2.01	1.47	0.99	1.75	1.22	-2.08	2.38	2	42
Heavy truck and bus drivers	833	1.70	1.00	1.25	1.90	1.51	0.99	1.75	1.37	-2.18	1.61	2	62
Mobile plant operators	834	1.37	0.84	1.54	2.19	1.10	0.97	1.49	1.36	-3.02	3.33	1	30
Domestic, hotel and office cleaners and helpers	911	1.28	0.72	2.13	1.58	0.97	0.93	1.75	0.95	-3.63	91.61	1	155
Vehicle, window, laundry and other hand cleaning workers	912	0.49	0.78	1.90	1.32	1.10	1.16	1.44	0.63	-4.33	70.00	1	10
Agricultural, forestry and fishery labourers	921	0.92		1.39	2.05	0.30	0.93	1.75	1.28		34.15	1	41
Mining and construction labourers	931	1.55		1.55	2.79	0.44	1.11	1.75	0.32		0.00	1	22
Transport and storage labourers	933	1.74	0.98	1.39	1.87	1.32	0.93	1.75	1.27	-2.46	24.49	2	49
Food preparation assistants	941	1.20	1.35	1.48	2.16	0.79	0.86	1.75	1.70	-2.88	80.00	1	25
Other elementary workers	962	1.20	1.18	1.55	2.25	1.46	1.32	1.75	1.59	-2.35	23.53	1	51
SWEDEN	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Commissioned armed forces officers	11	2.32	2.55	2.92	2.00	2.65	2.91	3.01	2.47	1.48	22.22	4	18
Administrative and commercial managers	12	2.55	2.80	2.60	2.17	2.69	2.91	2.41	2.44	1.85	27.27	4	77
Production and specialised services managers	13	2.23	2.52	2.60	2.17	2.71	2.77	3.01	2.35	1.36	50.00	4	72
Hospitality, retail and other services managers	14	2.28	1.78	2.92	2.09	2.60	2.91	3.01	2.21	0.66	33.33	4	33
Non-commissioned armed forces officers	21	2.52	2.32	2.50	2.17	2.58	2.10	1.96	2.27	1.25	35.09	4	114
Health professionals	22	1.74	1.43	2.13	2.17	2.48	2.52	1.96	2.08	-0.24	76.09	2	138
Teaching professionals	23	1.74	1.67	2.13	2.17	2.63	2.80	2.41	1.87	-0.08	69.23	2	247
Business and administration professionals	24	2.19	2.45	2.59	2.16	2.55	2.36	1.96	2.27	1.04	50.33	4	153
Information and communications technology professionals	25	2.25	2.45	2.31	2.17	2.48	2.07	1.96	2.05	0.83	25.74	4	101
Legal, social and cultural professionals	26	1.55	2.02	2.40	2.17	2.57	2.26	1.78	2.07	0.09	62.50	2	112
Armed forces occupations, other ranks	31	2.37	2.07	2.31	2.17	2.51	2.19	1.96	1.98	0.65	14.47	4	159
Health associate professionals	32	1.83	1.55	2.04	1.82	2.26	1.97	1.75	1.72	-0.62	87.80	3	41
Business and administration associate professionals	33	2.37	2.27	2.40	2.17	2.46	2.23	1.75	1.95	0.70	51.77	4	282
Legal, social, cultural and related associate professionals	34	1.55	1.60	2.40	2.05	2.27	2.55	2.01	1.90	-0.65	64.00	1	50
Information and communications technicians	35	1.69	2.25	2.22	2.30	2.56	1.95	1.80	2.19	0.45	13.16	2	38
General and keyboard clerks	41	1.88	1.98	2.62	1.99	2.29	1.61	1.75	1.69	-0.27	85.71	3	35

Customer services clerks	42	1.75	1.75	1.77	2.16	2.21	1.87	1.75	1.74	-0.58	86.05	3	43
Numerical and material recording clerks	43	2.15	1.88	2.30	1.96	2.15	1.69	1.75	1.74	-0.23	63.49	3	63
Other clerical support workers	44	0.48	0.92	1.37	1.40	1.98	1.17	1.75	1.15	-2.87	66.67	1	18
Personal service workers	51	1.55	1.30	2.32	1.93	2.09	1.87	1.75	1.41	-1.43	44.25	1	113
Sales workers	52	2.02	1.30	2.05	1.93	2.03	2.21	1.75	1.34	-1.18	60.98	3	123
Personal care workers	53	1.09	1.05	1.86	1.94	2.01	1.85	1.75	1.88	-1.70	84.47	1	322
Protective services workers	54	1.03	1.30	2.13	1.75	2.23	2.06	1.39	2.48	-0.86	12.90	1	31
Market-oriented skilled agricultural workers	61	1.88	1.15	2.79	1.90	2.48	1.86	1.96	1.44	-0.82	30.51	3	59
Building and related trades workers, excluding electricians	71	1.68	1.21	2.31	1.89	1.77	1.74	1.75	1.56	-1.62	2.56	2	117
Metal, machinery and related trades workers	72	1.82	1.19	2.13	2.17	1.95	1.68	1.75	1.67	-1.24	6.45	3	93
Handicraft and printing workers	73	1.53	1.04	1.68	1.61	1.94	1.38	1.75	1.60	-1.66	15.79	1	19
Electrical and electronic trades workers	74	1.59	1.28	2.38	1.89	2.15	1.77	1.75	1.87	-0.99	0.00	2	39
Food processing, wood working, garment and other craft and related trades workers	75	1.99	1.09	2.21	1.96	2.02	1.79	1.96	1.08	-1.55	17.65	3	17
Stationary plant and machine operators	81	1.44	1.10	1.86	1.58	1.86	1.58	1.75	1.67	-1.71	20.63	1	63
Assemblers	82	1.20	0.87	1.62	1.18	1.51	1.47	1.50	1.61	-2.49	38.24	1	34
Drivers and mobile plant operators	83	1.38	0.87	1.94	1.74	1.70	1.29	1.75	1.67	-2.09	9.42	1	138
Cleaners and helpers	91	1.56	1.03	2.03	1.32	1.33	1.07	1.75	1.25	-2.56	79.55	2	44
Labourers in mining, construction, manufacturing and transport	93	1.66	0.73	1.97	1.64	1.26	1.39	1.32	1.17	-2.84	33.33	2	24
Food preparation assistants	94	1.40	1.03	1.68	1.91	1.63	1.67	1.75	1.12	-2.46	75.00	1	16
Refuse workers and other elementary workers	96	1.73	1.03	1.74	1.88	1.86	1.75	1.25	0.75	-2.23	20.00	2	10
USA	occup	num	ict	task	learn	read	influence	plan	write	pccog	pcf	numquartiles	N
Commissioned armed forces officers	11	2.55	3.12	2.71	2.16	2.79	3.14	3.73	2.44	2.18	32.65	4	49
Administrative and commercial managers	12	2.84	3.07	2.41	2.16	2.68	2.74	3.01	2.63	2.40	41.75	4	103
Production and specialised services managers	13	2.79	2.87	2.48	2.26	2.79	2.95	3.01	2.73	2.43	35.16	4	128
Hospitality, retail and other services managers	14	2.48	2.07	1.95	2.04	2.53	3.07	3.01	2.25	0.97	52.38	4	63
Non-commissioned armed forces officers	21	3.09	2.54	2.13	2.05	2.68	1.89	1.75	2.38	2.05	28.24	4	85
Health professionals	22	2.28	1.49	1.74	2.44	2.54	2.64	1.88	2.56	0.66	82.40	3	125
Teaching professionals	23	2.17	2.22	1.78	2.40	2.82	3.37	3.73	2.56	1.38	68.37	3	196
Business and administration professionals	24	2.60	2.80	2.31	2.07	2.56	2.32	1.96	2.35	1.67	54.31	4	116

UK	occup	num	ict	task	learn	read	influence	plan	write	pcf	pccog	numquartiles	N
Information and communications technology professionals	25	2.35	2.94	2.13	2.30	2.75	1.98	1.75	2.36	1.78	27.50	3	80
Legal, social and cultural professionals	26	1.76	2.09	2.03	1.96	2.57	2.54	1.96	2.34	0.52	57.52	1	113
Armed forces occupations, other ranks	31	2.68	1.72	1.87	2.41	2.32	2.40	2.71	2.44	0.80	14.00	4	100
Health associate professionals	32	1.98	1.69	1.54	2.06	2.29	2.15	1.75	2.47	0.22	80.00	2	95
Business and administration associate professionals	33	2.42	2.45	1.97	2.07	2.39	2.29	1.75	2.45	1.19	72.93	3	229
Legal, social, cultural and related associate professionals	34	1.82	1.74	2.13	2.26	2.40	2.39	1.96	2.25	0.08	63.16	1	76
Information and communications technicians	35	1.91	2.32	2.13	2.81	2.79	2.27	1.96	2.29	1.00	30.43	2	23
General and keyboard clerks	41	1.95	2.22	1.91	1.85	2.09	1.54	1.70	1.93	-0.08	96.92	2	65
Customer services clerks	42	2.25	2.06	1.47	2.21	2.27	2.27	1.49	1.93	0.24	72.62	3	84
Numerical and material recording clerks	43	2.45	2.62	1.89	2.13	2.02	1.91	1.75	2.25	0.77	54.90	4	51
Other clerical support workers	44	1.93	2.06	1.63	1.92	1.98	1.75	1.49	1.93	-0.32	62.50	2	32
Personal service workers	51	1.88	1.06	1.56	1.93	1.62	1.89	1.50	1.36	-1.90	62.00	2	150
Sales workers	52	2.37	1.25	1.77	2.30	1.91	2.37	1.65	1.89	-0.64	67.36	3	242
Personal care workers	53	1.53	1.20	1.59	2.08	1.94	2.17	1.65	1.96	-1.25	85.16	1	155
Protective services workers	54	1.57	1.68	1.47	2.45	2.47	2.40	1.55	3.18	0.64	18.33	1	60
Market-oriented skilled agricultural workers	61	2.14	1.11	1.85	2.04	2.05	1.89	3.01	1.78	-0.85	12.50	2	32
Building and related trades workers, excluding electricians	71	2.21	1.21	1.59	2.16	1.79	1.73	1.41	1.27	-1.41	4.65	3	86
Metal, machinery and related trades workers	72	2.23	1.08	1.71	2.16	2.09	1.85	1.75	1.80	-0.73	4.65	3	86
Electrical and electronic trades workers	74	1.77	1.70	1.96	2.26	2.08	2.15	1.75	1.93	-0.59	7.41	1	27
Food processing, wood working, garment and other craft and related trades workers	75	2.35	1.21	1.42	1.96	1.78	1.85	1.61	1.93	-0.79	32.35	3	34
Stationary plant and machine operators	81	2.06	1.10	1.24	2.16	1.47	1.49	1.22	1.21	-1.99	33.96	2	53
Assemblers	82	1.83	0.93	1.31	1.45	1.30	0.81	1.25	1.00	-2.64	37.50	1	24
Drivers and mobile plant operators	83	2.01	0.97	1.39	2.13	1.96	1.80	1.55	1.69	-1.21	16.67	2	102
Cleaners and helpers	91	1.32	1.10	2.01	1.79	1.17	1.52	1.48	1.00	-3.09	71.43	1	42
Agricultural, forestry and fishery labourers	92	1.79	0.61	1.60	2.28	1.20	1.57	1.70	0.95	-3.04	9.52	1	21
Labourers in mining, construction, manufacturing and transport	93	1.73	0.69	1.27	2.13	1.47	1.61	1.48	1.22	-2.53	15.87	1	63
Food preparation assistants	94	1.56	0.66	1.32	1.63	1.08	1.66	1.00	0.86	-3.40	48.78	1	41
Refuse workers and other elementary workers	96	2.02	1.17	1.63	1.79	1.39	1.57	1.62	1.36	-1.95	10.34	2	29

Legislators and senior officials	111	1.92	2.31	2.13	1.53	2.49	2.50	3.01	2.56	73.68	0.88	3	19
Business services and administration managers	121	2.49	2.62	2.15	1.93	2.39	2.64	3.01	2.63	60.13	1.49	4	153
Sales, marketing and development managers	122	2.87	2.92	2.40	2.17	2.53	2.98	3.01	2.67	48.96	2.20	4	96
Manufacturing, mining, construction, and distribution managers	132	2.68	2.62	2.13	2.04	2.49	2.87	3.73	2.44	27.34	1.61	4	128
Information and communications technology service managers	133	2.46	3.17	2.31	2.05	2.65	2.34	3.01	2.73	27.03	2.22	4	37
Professional services managers	134	2.16	2.32	2.04	1.85	2.49	2.88	3.01	2.89	66.67	1.34	3	42
Hotel and restaurant managers	141	2.25	1.55	1.83	1.90	2.03	2.72	3.01	1.89	46.88	-0.40	3	32
Retail and wholesale trade managers	142	2.41	2.13	2.31	2.07	2.47	3.00	3.73	2.27	47.92	0.91	4	48
Other services managers	143	2.29	2.62	2.36	1.75	2.48	2.84	3.73	2.57	63.24	1.39	4	68
Physical and earth science professionals	211	2.92	2.31	2.24	2.00	2.70	2.41	1.96	2.47	31.58	1.83	4	19
Life science professionals	213	2.13	2.39	2.01	2.26	2.63	2.30	2.41	2.91	56.25	1.53	3	16
Engineering professionals (excluding electrotechnology)	214	2.86	2.56	2.04	1.77	2.67	2.37	2.41	2.44	10.91	1.92	4	55
Architects, planners, surveyors and designers	216	2.64	2.49	2.13	1.93	2.64	2.42	3.01	2.44	29.85	1.66	4	67
Medical doctors	221	1.94	1.83	1.38	2.51	2.84	2.79	1.96	2.73	51.61	1.09	3	31
Other health professionals	226	1.50	1.74	1.54	2.13	2.42	2.60	1.96	2.73	67.69	0.23	1	65
University and higher education teachers	231	1.89	2.27	1.95	2.25	2.98	3.24	3.01	2.63	62.30	1.42	2	61
Secondary education teachers	233	1.85	2.10	1.35	2.04	2.80	4.26	3.73	2.56	71.26	1.02	2	87
Primary school and early childhood teachers	234	1.92	1.91	1.54	2.26	2.74	3.29	3.73	2.44	80.56	0.80	3	108
Other teaching professionals	235	1.68	2.00	1.97	2.13	2.49	3.10	3.73	2.44	72.00	0.39	2	100
Finance professionals	241	3.42	2.94	2.40	2.00	2.56	2.22	2.23	2.38	51.11	2.45	4	45
Administration professionals	242	2.12	2.72	2.13	1.96	2.53	2.51	2.41	2.60	65.38	1.40	3	52
Software and applications developers and analysts	251	2.41	2.94	2.06	2.16	2.60	2.08	1.75	2.21	14.67	1.55	4	75
Legal professionals	261	1.83	2.23	2.13	2.17	3.04	2.81	2.18	2.63	51.22	1.42	2	41
Social and religious professionals	263	1.60	1.85	1.96	2.16	2.52	2.83	3.01	2.91	65.22	0.63	2	69
Authors, journalists and linguists	264	1.58	2.10	2.13	1.68	2.46	1.85	1.96	2.15	58.33	0.11	1	24
Creative and performing artists	265	1.93	2.41	2.60	2.21	2.69	2.51	3.01	2.19	42.86	0.89	3	35
Physical and engineering science technicians	311	2.44	2.10	1.86	2.10	2.23	1.95	1.96	2.53	27.45	0.85	4	51
Nursing and midwifery associate professionals	322	2.05	1.37	1.47	2.41	2.54	2.91	3.01	2.95	92.03	0.70	3	138
Other health associate professionals	325	1.96	1.91	1.71	1.85	2.55	2.27	1.96	2.73	57.89	0.84	3	38

Financial and mathematical associate professionals	331	2.66	2.62	2.13	2.10	2.54	2.43	1.96	2.56	45.32	1.74	4	139
Sales and purchasing agents and brokers	332	2.37	2.44	2.13	2.03	2.22	2.45	1.75	2.37	53.76	0.88	4	93
Business services agents	333	2.48	2.10	2.60	1.79	1.92	2.19	2.41	1.93	27.27	0.08	4	11
Regulatory government associate professionals	335	1.96	2.23	2.21	2.07	2.38	1.99	1.96	2.53	68.42	0.71	3	19
Legal, social and religious associate professionals	341	1.70	2.04	2.04	2.11	2.20	2.66	3.01	2.65	63.64	0.29	2	66
Sports and fitness workers	342	1.89	1.70	2.04	2.29	2.33	2.83	3.01	1.94	61.54	-0.21	2	26
Artistic, cultural and culinary associate professionals	343	1.87	2.38	2.13	2.45	2.39	2.52	1.96	2.07	47.06	0.40	2	17
Information and communications technology operations and user support technicians	351	2.17	3.17	1.70	2.26	2.42	1.99	1.78	2.35	26.00	1.44	3	50
Secretaries (general)	412	1.70	2.32	2.13	1.61	2.10	1.94	2.71	2.15	93.55	-0.03	2	93
Keyboard operators	413	1.65	2.20	1.75	1.78	2.05	1.48	1.45	2.32	70.00	-0.08	2	10
Tellers, money collectors and related clerks	421	2.14	1.72	1.25	2.25	2.22	2.27	1.96	1.93	72.09	-0.13	3	43
Client information workers	422	1.92	2.07	1.39	2.17	1.99	2.01	1.75	1.93	79.85	-0.32	2	134
Numerical clerks	431	2.61	2.53	2.09	1.64	1.95	1.80	1.75	2.07	81.88	0.61	4	138
Material-recording and transport clerks	432	2.23	1.95	1.39	1.74	1.95	2.26	1.75	2.33	47.50	0.12	3	40
Other clerical support workers	441	1.88	2.10	1.71	1.92	2.01	2.03	1.75	2.06	75.43	-0.21	2	350
Travel attendants, conductors and guides	511	1.55	1.23	1.38	2.13	1.96	2.24	1.31	2.13	72.73	-1.07	1	11
Cooks	512	1.86	1.18	1.80	1.95	1.61	1.63	1.50	1.48	47.62	-1.75	2	42
Waiters and bartenders	513	1.51	0.72	1.39	1.70	0.95	1.75	1.32	1.00	80.00	-3.43	1	55
Hairdressers, beauticians and related workers	514	1.56	0.99	2.01	2.33	1.85	1.90	1.75	1.17	93.33	-2.08	1	60
Building and housekeeping supervisors	515	0.68	1.09	2.00	1.50	1.43	1.22	1.75	1.00	66.67	-3.31	1	30
Other personal services workers	516	1.55	0.97	1.30	1.72	1.35	2.08	1.45	1.09	72.73	-2.72	1	11
Shop salespersons	522	1.99	1.19	1.39	1.93	1.69	1.96	1.75	1.00	69.39	-1.91	3	294
Other sales workers	524	2.37	2.24	1.39	3.05	1.97	2.17	1.70	1.91	70.59	0.11	4	17
Child care workers and teachers' aides	531	1.40	1.18	1.39	2.25	2.10	2.50	1.96	2.00	97.89	-1.16	1	237
Personal care workers in health services	532	1.34	1.21	1.31	2.08	1.87	2.15	1.75	2.33	90.53	-1.20	1	243
Protective services workers	541	1.45	1.74	1.38	1.93	2.18	2.25	1.75	2.64	25.61	-0.15	1	82
Market gardeners and crop growers	611	1.43	1.26	2.17	1.83	1.82	1.71	1.86	1.28	6.67	-1.96	1	30
Mixed crop and animal producers	613	1.31	0.96	1.84	2.01	2.23	1.36	1.75	0.89	10.53	-2.10	1	38
Building frame and related trades workers	711	1.95	1.27	1.84	1.93	1.70	1.95	2.23	1.32	0.00	-1.63	3	79

Building finishers and related trades workers	712	1.84	1.52	1.84	2.13	2.03	2.15	1.96	1.65	2.33	-0.93	2	43
Painters, building structure cleaners and related trades workers	713	1.20	0.91	2.22	1.45	1.34	1.42	1.75	1.16	11.11	-3.00	1	18
Sheet and structural metal workers, moulders and welders, and related workers	721	1.70	1.48	1.39	1.65	1.60	1.45	1.41	1.00	11.54	-2.05	2	26
Blacksmiths, toolmakers and related trades workers	722	3.01	1.34	1.39	1.69	1.53	1.69	1.75	1.80	0.00	-0.55	4	17
Machinery mechanics and repairers	723	1.90	1.09	1.47	2.01	1.89	1.61	1.75	1.86	2.90	-1.17	2	69
Handicraft workers	731	2.02	1.21	2.31	1.99	1.69	1.80	2.38	1.55	36.36	-1.45	3	11
Printing trades workers	732	2.52	2.16	2.04	1.18	1.91	1.71	1.86	1.99	10.00	0.18	4	10
Electrical equipment installers and repairers	741	1.91	1.34	1.54	1.73	1.99	1.92	1.75	1.86	0.00	-0.89	2	43
Electronics and telecommunications installers and repairers	742	1.84	2.21	1.95	2.04	2.30	2.17	1.75	2.48	0.00	0.49	2	33
Food processing and related trades workers	751	2.01	0.85	1.62	2.01	1.68	1.70	1.80	1.27	6.25	-1.93	3	16
Chemical and photographic products plant and machine operators	813	1.92	1.03	1.36	1.67	1.82	1.92	2.41	1.67	35.71	-1.41	3	14
Food and related products machine operators	816	2.14	1.36	0.94	1.79	1.29	1.41	1.75	1.11	37.93	-2.03	3	29
Other stationary plant and machine operators	818	2.01	1.24	1.54	1.88	1.62	1.69	1.75	2.00	21.43	-1.16	3	42
Assemblers	821	1.82	1.20	0.94	2.08	1.49	0.98	1.31	1.02	21.43	-2.24	2	14
Car, van and motorcycle drivers	832	1.40	1.05	1.46	1.60	1.53	1.49	1.75	1.06	14.52	-2.61	1	62
Heavy truck and bus drivers	833	1.30	0.77	1.04	1.02	1.70	1.23	1.75	1.38	3.80	-2.44	1	79
Mobile plant operators	834	1.20	0.77	1.18	1.42	1.27	1.51	1.75	1.00	0.00	-3.29	1	32
Domestic, hotel and office cleaners and helpers	911	1.38	0.89	1.47	1.61	1.05	1.19	1.75	1.00	79.13	-3.31	1	206
Mining and construction labourers	931	1.83	1.33	1.90	2.05	1.70	1.59	1.56	1.35	0.00	-1.66	2	49
Manufacturing labourers	932	1.48	1.56	1.39	1.92	1.40	1.34	1.33	1.00	51.52	-2.40	1	33
Transport and storage labourers	933	1.40	1.07	1.31	1.93	1.65	1.77	1.49	1.32	16.22	-2.26	1	74
Other elementary workers	962	1.20	1.21	1.32	1.61	1.58	1.52	1.75	1.00	34.62	-2.65	1	52

Table A5.6 Gender (male) odds ratios from logistic regression models, five specifications, low and high numeracy levels

Low numeracy	Model 1		Model 2		Model 3a		Model 3b		Model 3c	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Belgium	0.59***	0.09	0.67***	0.10	0.68***	0.11	0.64***	0.10	0.65***	0.10
Czech Republic	0.58***	0.10	0.57***	0.10	0.51***	0.09	0.52***	0.09	0.50***	0.09
Denmark	0.63***	0.07	0.73***	0.09	0.68***	0.09	0.71***	0.09	0.65***	0.08
France	0.75***	0.06	0.80***	0.08	0.80***	0.07	0.81***	0.07	0.80***	0.07
Germany	0.51***	0.06	0.58***	0.08	0.54***	0.08	0.55***	0.08	0.52***	0.08
Ireland	0.53***	0.05	0.57***	0.06	0.54***	0.06	0.57***	0.06	0.56***	0.06
Italy	0.85***	0.11	0.89***	0.12	0.98***	0.13	0.98***	0.14	0.97	0.13
Japan	0.92**	0.10	0.96*	0.12	1.01	0.13	0.97	0.12	0.97	0.12
Korea	0.88***	0.08	0.88***	0.08	0.90***	0.08	0.90***	0.08	0.90***	0.08
Netherlands	0.73***	0.09	0.77***	0.09	0.76***	0.10	0.75***	0.09	0.75***	0.10
Norway	0.57***	0.07	0.67***	0.09	0.62***	0.08	0.61***	0.08	0.62***	0.09
Poland	0.71***	0.08	0.72***	0.09	0.71***	0.09	0.72***	0.09	0.71***	0.09
Slovak Republic	0.96	0.13	0.93**	0.13	0.95**	0.14	0.98	0.15	0.99	0.15
Spain	0.49***	0.05	0.51***	0.06	0.49***	0.06	0.50***	0.06	0.50***	0.06
Sweden	0.68***	0.08	0.93***	0.13	0.86***	0.12	0.88***	0.12	0.88***	0.12
UK	0.69***	0.07	0.69***	0.08	0.67***	0.08	0.66	0.08	0.68***	0.08
USA	0.70***	0.07	0.72***	0.08	0.71***	0.07	0.71	0.07	0.71***	0.07

High numeracy										
	Model 1		Model 2		Model 3a		Model 3b		Model 3c	
Belgium	2.54***	0.26	2.52***	0.26	2.57***	0.28	2.70***	0.29	2.58***	0.28
Czech Republic	1.87***	0.29	1.93***	0.32	2.00***	0.36	1.91***	0.33	1.99***	0.35
Denmark	2.54***	0.25	2.43***	0.25	2.38***	0.23	2.47***	0.25	2.45***	0.24
France	1.99***	0.17	2.04***	0.18	2.02***	0.18	2.02***	0.18	2.03	0.18
Germany	2.22***	0.19	2.07***	0.19	2.08***	0.20	2.09***	0.21	2.14***	0.21
Ireland	2.52***	0.23	2.53***	0.24	2.54***	0.24	2.56***	0.24	2.50***	0.24
Italy	2.14***	0.27	2.01***	0.27	1.95***	0.29	1.95***	0.29	1.97***	0.29
Japan	1.77***	0.15	1.60***	0.14	1.53***	0.13	1.59***	0.14	1.55***	0.14
Korea	1.59***	0.19	1.83***	0.24	1.84***	0.25	1.85***	0.25	1.84***	0.25
Netherlands	1.97***	0.17	1.85***	0.17	1.87***	0.18	1.90***	0.18	1.88***	0.18
Norway	2.26***	0.24	1.92***	0.20	1.89***	0.21	1.90***	0.21	1.88***	0.21
Poland	1.56***	0.20	1.57***	0.20	1.62***	0.21	1.63***	0.22	1.57***	0.20
Slovak Republic	1.17***	0.14	1.17***	0.13	1.24***	0.15	1.21***	0.14	1.22***	0.14
Spain	2.72***	0.35	2.76***	0.36	2.57***	0.36	2.55***	0.35	2.52***	0.35
Sweden	1.99***	0.21	1.72***	0.19	1.80***	0.20	1.77***	0.20	1.77***	0.20
UK	1.80***	0.19	1.71***	0.20	1.72***	0.21	1.72***	0.21	1.71***	0.20
USA	2.18***	0.28	2.20***	0.29	2.20***	0.30	2.21***	0.28	2.14***	0.29

Source: Author's calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied. Odds ratios and significance levels reported in Appendix A5.5. Model 1 (M1) includes gender, immigrant status, parental education, educational attainment (upper secondary, tertiary, and post-secondary, non-tertiary compared to all levels below), field of study (science + mathematics; engineering and a missing field dummy where necessary, compared to all other fields). Model 2 (M2) adds variables representing occupation ISEI score and industry sector. Models 3a-3c each build on Model 2, adding a variable representing occupation numeracy-intensiveness (coded so that higher values = lower numeracy-intensiveness) (3a); a dummy variable representing the lowest quartile of numeracy-intensiveness (3b), and a dummy variable representing the highest quartile of numeracy-intensiveness (3c). Coefficients which represent a statistically significant change from the previous models are highlighted in grey. 'High numeracy' = above 304 points. 'Low numeracy' = below 238 points.

APPENDIX TO CHAPTER 6.

Part 1. Descriptive statistics

Table A6.1 Residual gender difference in high numeracy (odds ratio male), three analytical samples

	25-34		55-64		Working adults	
	OR	SE	OR	SE	OR	SE
Belgium	2.32	0.46	2.50	0.55	2.70	0.29
Czech Republic	1.76	0.23	1.34	0.48	1.91	0.33
Denmark	2.57	0.46	2.36	0.29	2.47	0.25
France	1.87	0.23	2.37	0.41	2.02	0.18
Germany	1.64	0.30	2.47	0.48	2.09	0.21
Ireland	2.21	0.36	4.99	1.43	2.56	0.24
Japan	1.30	0.21	1.91	0.37	1.59	0.14
Korea	1.78	0.29	1.87	0.69	1.85	0.25
Netherlands	2.09	0.33	2.47	0.48	1.90	0.18
Norway	2.45	0.43	2.44	0.54	1.90	0.21
Poland	1.59	0.27	0.57	0.16	1.63	0.22
Slovak Republic	1.13	0.20	1.09	0.20	1.21	0.14
Spain	1.77	0.33	3.16	1.65	2.55	0.35
Sweden	2.44	0.41	2.12	0.43	1.77	0.20
UK	1.44	0.26	1.72	0.33	1.72	0.21
USA	2.17	0.42	1.87	0.37	2.21	0.28

Table A6.2 Residual gender difference in low numeracy (odds ratio male), three analytical samples

	25-34		55-64		Working adults	
	OR	SE	OR	SE	OR	SE
Belgium	0.47	0.14	0.52	0.09	0.68	0.11
Czech Republic	0.41	0.14	1.66	0.40	0.51	0.09
Denmark	0.66	0.17	0.68	0.09	0.68	0.09
France	0.67	0.11	0.74	0.08	0.80	0.07
Germany	0.61	0.16	0.44	0.09	0.54	0.08
Ireland	0.69	0.10	0.47	0.07	0.54	0.06
Japan	1.09	0.26	0.98	0.18	1.01	0.13
Korea	0.78	0.17	0.48	0.06	0.90	0.08
Netherlands	0.67	0.19	0.65	0.10	0.76	0.10
Norway	0.59	0.16	0.64	0.12	0.62	0.08
Poland	0.79	0.14	0.83	0.15	0.71	0.09
Slovak Republic	1.02	0.21	1.31	0.23	0.95	0.14
Spain	0.64	0.11	0.51	0.08	0.49	0.06
Sweden	0.76	0.22	0.53	0.10	0.86	0.12
UK	0.53	0.10	0.69	0.12	0.67	0.08
USA	0.61	0.09	0.77	0.11	0.71	0.07

Table A6.3 Occupation numeracy intensiveness – employment by gender in quartiles (proportion of all female/male employment)

	Men								Women								All adults							
	Quartile 1 (lowest)		**2**		**3**		**Quartile 4 (highest)**		**Quartile 1 (lowest)**		**2**		**3**		**Quartile 4 (highest)**		**Quartile 1 (lowest)**		**2**		**3**		**Quartile 4 (highest)**	
Country	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
Belgium	23.6	0.94	27.55	0.99	15.95	0.94	32.89	1.1	25.96	1.29	31.15	1.29	25.46	1.24	17.43	0.95	24.7	0.83	29.21	0.79	20.35	0.73	25.74	0.74
Czech Republic	21.81	1.45	31.58	1.9	20.65	2.1	25.96	1.37	30.95	1.66	13.96	1.39	24.34	1.57	30.75	1.56	25.82	1.19	23.85	1.38	22.27	1.34	28.06	1.1
Denmark	21.68	0.96	17.82	0.8	26.65	0.94	33.86	1.13	32.07	1.26	28.82	1.2	13.67	0.91	25.44	1.32	26.62	0.8	23.05	0.71	20.48	0.6	29.86	0.8
France	23.58	0.8	25.2	0.89	30.24	0.97	20.99	0.77	34.27	0.92	16.4	0.7	30.01	0.94	19.33	0.71	28.78	0.62	20.91	0.57	30.12	0.76	20.18	0.5
Germany	22.9	1.3	24.92	1.07	24.13	1.16	28.05	1.14	29.01	1.37	21.39	1.19	25.17	1.26	24.43	1.27	25.71	1.02	23.3	0.8	24.61	0.88	26.39	0.83
Ireland	25.98	1.4	27.05	1.23	16.35	1.1	30.62	1.4	27.84	1.19	30.56	1.31	18	1.02	23.6	1.32	26.88	0.9	28.75	0.93	17.15	0.73	27.23	1.04
Italy	26.3	1.62	22.89	1.37	25.62	1.58	25.19	1.15	29.98	1.88	19.2	1.47	25.87	1.63	24.95	1.61	27.81	1.43	21.37	1.12	25.72	1.11	25.09	0.95
Japan	15.78	0.92	21.67	0.88	34.05	1.28	28.5	1.19	24.41	1.19	40.91	1.42	24.6	1.17	10.08	0.81	19.47	0.69	29.89	0.8	30.01	0.86	20.63	0.78
Korea	23.95	0.93	15.55	0.97	21.51	0.99	38.99	1.06	36.66	1.12	9.73	0.76	28.85	1.15	24.76	1.08	29.21	0.72	13.14	0.65	24.55	0.76	33.1	0.77
Netherlands	16.91	0.99	19.37	0.87	25.73	0.91	37.98	1.24	34.53	1.21	24.08	1.01	24.02	1.14	17.37	1.02	25.1	0.83	21.56	0.64	24.94	0.78	28.4	0.77
Norway	19.19	0.94	19.63	0.98	32.1	0.95	29.08	0.91	34.98	1.11	24.39	1.25	23.98	1.14	16.65	1.06	26.61	0.66	21.87	0.71	28.29	0.72	23.24	0.64
Poland	32.05	1.14	27.57	1.15	16.77	0.94	23.62	1.05	17.22	1.09	23.81	1.42	32.12	1.4	26.85	1.44	25.34	0.79	25.87	0.85	23.71	0.86	25.08	0.89
Slovak Republic	28.1	1.22	27.57	1.15	18.61	1.01	25.71	1.29	18.31	1.15	25.54	1.33	27.83	1.41	28.31	1.27	23.73	0.85	26.66	0.96	22.73	0.96	26.88	0.95
Spain	23.36	1.16	28.71	1.2	27.6	1.22	20.33	1.1	33.04	1.54	14.9	1.09	36.91	1.55	15.15	1.09	27.83	0.96	22.34	0.78	31.89	0.9	17.94	0.74
Sweden	24.49	1.08	23.66	1.14	16.37	0.94	35.48	1.05	32.22	1.05	24.36	0.97	18.06	1.05	25.36	1.29	28.13	0.76	23.99	0.76	17.16	0.72	30.72	0.82

USA	20.34	1.31	19.14	1.12	32.23	1.45	28.29	1.05	21.9	1.26	19.18	1.06	41.93	1.26	16.99	0.99	21.08	0.9	19.16	0.73	36.87	0.92	22.88	0.71
UK	24.2	1.24	24.25	1.26	19.64	1.1	31.91	1.27	32.64	1.37	23.99	1.12	22.42	1.01	20.95	1.06	28.21	0.86	24.13	0.86	20.96	0.76	26.7	0.8

Source: Author’s calculation using the PIAAC dataset. PIAAC sampling and replicate weights applied.

Part 2. Details of cluster analysis

Table A6.4 Cluster dataset

Country	LFP	Parliament	Meanhours_housework_FM	Wagegap	womanwork	jobrights	Dissim_industry	Yearsed	lownum_f	highnum_m
Belgium	47.10	38.00	6.70	6.41	18.40	17.70	0.34	0.45	2.36	15.46
Czech Republic	50.10	22.00	8.40	15.26	20.40	28.90	0.29	0.13	9.14	-4.79
Denmark	59.10	39.10	3.30	7.00	11.50	2.30	0.34	0.60	10.39	8.42
France	51.00	26.90	4.50	9.87	12.60	13.30	0.31	0.40	10.69	1.66
Germany	53.70	32.90	10.60	15.58	12.30	14.90	0.29	-0.25	6.11	3.62
Ireland	52.80	15.10	5.50	8.50	33.10	16.20	0.31	0.83	1.86	7.02
Japan	48.20	7.90	14.30	26.52	5.60	30.00	0.23	0.88	8.63	18.42
Korea	55.20	15.70	10.50	36.30	7.80	32.20	0.26	-0.11	12.71	14.23
Netherlands	58.70	38.70	3.70	14.11	30.50	12.50	0.32	-0.05	17.62	20.61
Norway	61.60	39.60	2.80	6.41	16.20	2.90	0.38	0.35	15.79	12.43
Poland	48.80	23.70	5.10	10.62	21.20	21.10	0.28	0.46	-14.8	-3.23
Slovak Republic	50.90	18.70	7.00	15.97	15.40	30.10	0.33	-0.03	-9.79	-2.6
Spain	52.50	36.00	11.70	11.54	13.60	16.60	0.29	0.50	9.68	5.18
Sweden	60.30	44.70	3.80	15.14	19.70	2.50	0.37	0.77	7.73	10.12
UK	56.00	22.50	3.70	17.78	36.20	13.60	0.32	0.19	8.44	10.96
USA	56.70	18.00	3.60	19.09	20.30	5.70	0.28	0.21	1.56	11.3

Table A6.5 Correlations between cluster variables

	LFP	Parliament	Meanhours_housework_FM	Wagegap	Womanwork	Jobrights	Dissim_industry	Yearsed	Lownum_f	Highnum_m
LFP	1.00	0.50	-0.56	-0.05	0.19	-0.72	0.55	-0.10	0.53	0.36
Parliament	0.50	1.00	-0.42	-0.59	0.05	-0.68	0.75	0.00	0.33	0.13
Meanhours_housework_FM	-0.56	-0.42	1.00	0.53	-0.57	0.71	-0.71	-0.04	0.01	0.00
Wagegap	-0.05	-0.59	0.53	1.00	-0.31	0.57	-0.65	-0.31	0.13	0.27
Womanwork	0.19	0.05	-0.57	-0.31	1.00	-0.25	0.31	-0.01	-0.08	0.04
Jobrights	-0.72	-0.68	0.71	0.57	-0.25	1.00	-0.66	-0.24	-0.29	-0.23
Dissim_industry	0.55	0.75	-0.71	-0.65	0.31	-0.66	1.00	0.09	0.14	0.02
Yearsed	-0.10	0.00	-0.04	-0.31	-0.01	-0.24	0.09	1.00	-0.07	0.14
Lownum_f	0.53	0.33	0.01	0.13	-0.08	-0.29	0.14	-0.07	1.00	0.57
Highnum_m	0.36	0.13	0.00	0.27	0.04	-0.23	0.02	0.14	0.57	1.00

Figure A6.1 Dendograms from three hierarchical clustering solutions

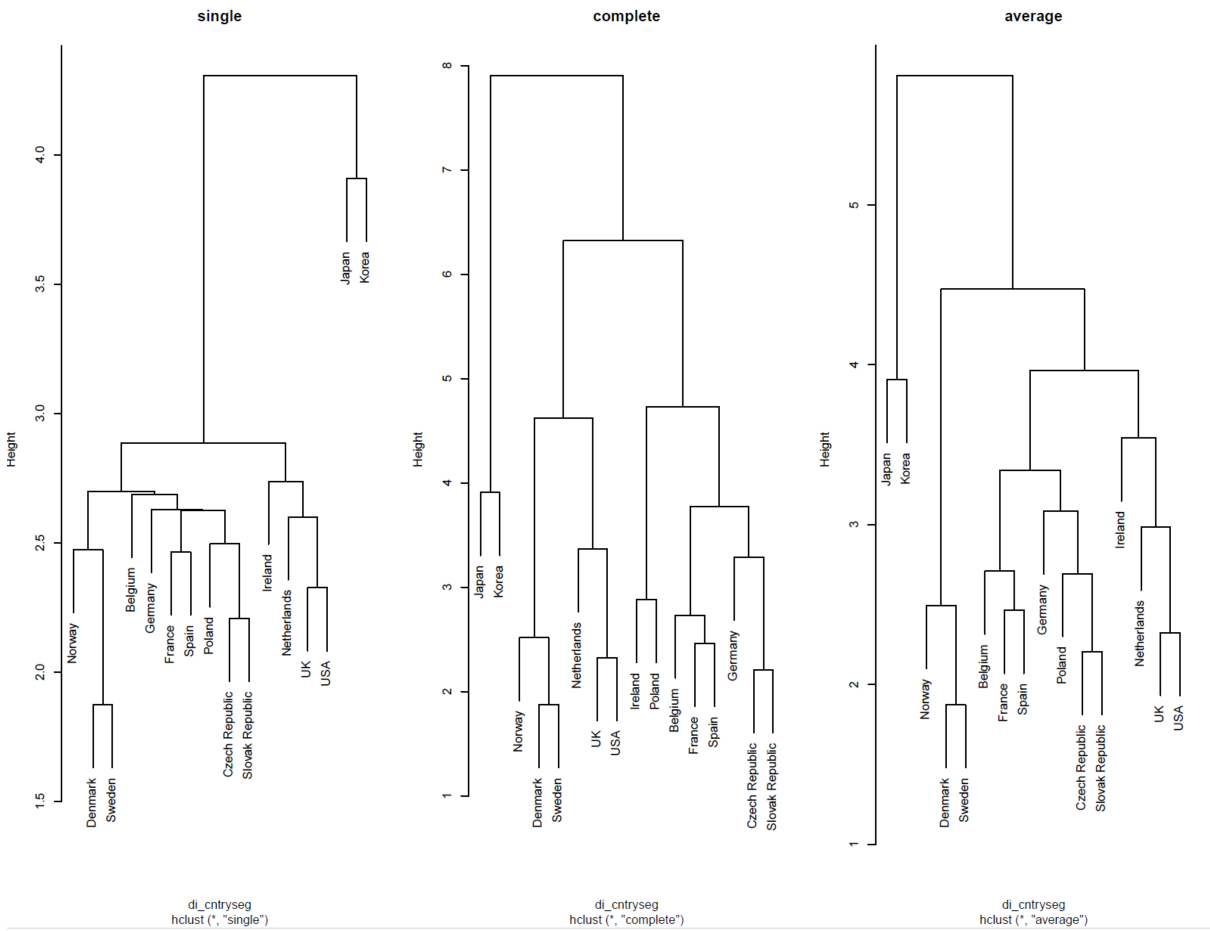

Figure A6.2 Scree plot from k-means clustering

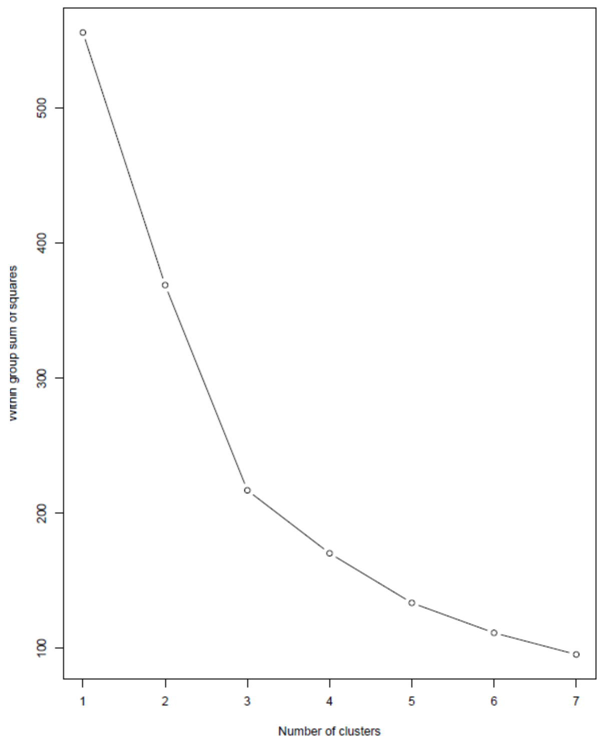

Table A6.6 Sensitivity analysis- sequential removal of indicators and resulting changes in clusters

Variables included	5 cluster solution
Base: Full model	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL UK USA) (4: CZE POL SVK) (5: BEL FR ES DEU)
(1) Base - Yearsed_fm	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL UK USA) (4: CZE POL SVK) (5: BEL FR ES DEU)
(2) Base - lfp_2012	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL POL) (4: CZE SVK DEU) (5: BEL FR ES UK USA)
(3) Base - Female MPs 2012	(1: JPN KOR) (2: DNK NOR SWE) (3: UK USA NLD) (4: CZE POL SVK DEU) (5: BEL FR ES IRL)
(4) Base - wagegap	(1: KOR CZE DEU ES) (2: DNK NLD NOR SWE) (3: JPN) (4: POL SVK) (5: BEL FR ES IRL UK USA)
(5) Base - Meanhours_housework_FM	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL UK USA) (4: CZE POL SVK) (5: BEL FR ES DEU)
(6) Base - Industry segregation	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL UK USA) (4: CZE POL SVK) (5: BEL FR ES DEU)
(7) Base - Female over-representation, low numeracy occupations	(1: JPN KOR) (2: DNK NOR SWE) (3: UK USA NLD) (4: CZE POL SVK DEU FR ES) (5: BEL IRL)
(8) Base - Male over-representation, high numeracy occupations	(1: JPN KOR) (2: DNK NOR SWE) (3: IRL UK USA NLD) (4: POL SVK) (5: BEL FR ES DEU CZE)
(9) Base - Male job rights	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: IRL UK USA) (4: POL SVK) (5: BEL FR ES DEU CZE)
(10) Base - Working main way for woman to be independent	(1: JPN KOR) (2: DNK NLD NOR SWE) (3: UK USA) (4: CZE POL SVK) (5: BEL FR ES DEU IRL)

Table A6.7 Four cluster solution

Cluster 1: East Asian	Cluster 2: Nordic
Japan	Denmark
Korea	Netherlands
	Norway
	Sweden
Cluster 3: Post-Soviet	**Cluster 4: Continental +Anglophone**
Poland	Belgium
Slovak Republic	France
Czech Republic	Spain
	Ireland
	UK
	USA
	Germany

Table A6.8 Six cluster solution

Cluster 1: East Asian	Cluster 2: Nordic	Cluster 5: Anglophone
Japan	Denmark	Ireland
Korea	Netherlands	UK
	Norway	USA
	Sweden	
Cluster 3: Post-Soviet	**Cluster 4: Continental**	**Cluster 6**
Poland	Belgium	Germany
Slovak Republic	France	Czech Republic
	Spain	

Table A6.9 Results from a two-step regression model predicting country-level gender differences in adult numeracy based on cluster membership, raw gender difference

	Young adults (25–34)		Older adults (55–64)		Working adults (16–65)	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**
East Asian	ref		ref		ref	
Anglophone	**7.22***	2.19	-0.4	4.02	2.01	2.6
Continental	**4.37***	1.89	-0.47	3.58	2.62	2.43
Nordic	**7.42****	2	-1.04	3.49	2.56	2.43
Post-Soviet	-2.21	2.07	**-17.07*****	3.83	**-6.32***	2.63
Adj. Rsquared	0.66		0.68		0.52	
Intercept	6.51		17.76		10.13	
N	16		16		16	